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MARINE ENGINEERING.

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NOTE.—Illustrated articles are marked with an asterisk (*) following the title.

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MARINE ENGINEERING.

Vol. 5. NEW YORK, JANUARY, 1900. No. 1

ADDITIONS TO THE U. S. NAVY—BATTLESHIPS KEARSARGE AND KENTUCKY.

Our naval fighting strength will soon be increased by the additions of the battleships *Kearsarge* and *Kentucky*, both of which have undergone their acceptance trials and are now receiving their proper equipment for naval service. In our engraving the *Kentucky* is shown steaming full speed ahead during her recent sea speed trials. Both these vessels were built at the Newport News yard and they are practically alike in all essential particulars. Their most peculiar feature is the superimposed turrets forward and aft, the larger and lower turrets, each carrying two 13-in. breech loaders, and the upper turrets each containing two 8-in. breech loaders. In addition in the main battery the vessels carry, broadside, fourteen 5-in. rapid fire guns, and in the secondary battery twenty 6-pounders and eight 1-pounder rapid fire guns, and also the usual automatic and field guns. The defensive powers are provided for by a side belt of Harveyized armor of a maximum thickness of 16 1-2 in. and armor plate disposed else-

U. S. BATTLESHIP KENTUCKY STEAMING "FULL SPEED AHEAD" ON HER TRIAL TRIP.
(*Original photograph, Copyright, 1899, by N. L. Stebbins, Boston, Mass.*)

where for the protection of the ship's vitals. The protective deck is 2 3-4 in. thick.

In former issues we gave the chief dimensions of these vessels and now add some particulars regarding the machinery equipment. They are twin screw vessels with engines of about 10,000 I. H. P. The engines are vertical inverted triple expansion, with wrought steel framing thoroughly trussed and stayed, and with cylinders, 33 1-2 in., 51 in., and 78 in. dia., and 48 in. stroke. Single ported piston valves are used throughout, one for the H. P., two for the I. P., and four for the L. P. cylinders. Stephenson's link motion is used for all valves. Steel forgings are extensively used for the working parts and the line, thrust and propeller shafts are hollow forged nickel steel. Independent pumps are fitted for all services. Manganese bronze is used for the propellers, which are three bladed, true screws, 16 ft. 9 in. dia. and with pitch adjustable from 16 ft. to 18 ft.

Fire tube cylindrical boilers are used; three double ended and two single ended, all 15 ft. 8 in. diameter.

Auxiliaries are numerous, covering a large number of pumps for a great variety of purposes from boiler feed to sanitary service; also ice machine, distilling apparatus, etc. A more general application of electricity for power purposes has been made on these ships than on any other of our naval vessels. The installation was the subject of a special paper read before the Society of Naval Architects and Marine Engineers, reported in our last issue.

Both these vessels have attained a speed considerably in excess of the contract 16 knots on trial. In his report the Secretary of the Navy announces that the *Kearsarge* will be completed for service this month and the *Kentucky* next month.

On trial the battleship *Kentucky* attained a speed of 16.897 knots, and the *Kearsarge* on trial attained a rate of 16.85 knots.

A. S. M .E. Meeting.—Members of the American Society of Mechanical Engineers met in New York December 5, on the occasion of the twentieth annual meeting. The presidential address by George W. Melville, Engineer-in-Chief of the Navy, treated of "Engineering the United States Navy; its Personnel and Matériel." A number of valuable papers on a variety of engineering subjects was read and discussed. Excursions to local points of interest, power plants, etc., were arranged for and participated in largely by the members. The social side of the meeting is always a strong one with the mechanical engineers, and besides excursions, other pleasant functions formed part of the programme. The solicitation of funds for the provision of a suitable memorial to Robert Fulton was actively carried out by a special committee appointed for that purpose. The remains of the great engineer lie in the Trinity Church grave yard in New York city, and arrangements have been made with the church authorities for the placing of the memorial. C. H. Morgan was elected President to succeed George W. Melville. We purpose in an early issue to republish the address of the retiring President. Charles H. Morgan, the new President, has long been connected with the steel and wire industry and is associated now with a company in Massachusetts bearing his name.

CAUSES FOR THE ADOPTION OF WATER TUBE BOILERS IN THE U. S. NAVY.*

BY GEO. W. MELVILLE, ENGINEER-IN-CHIEF, U. S. N.

It has been a number of years since I have had the honor and pleasure of addressing this Society. Speaking generally, the progress and design of machinery of warships has been during that time along such well-developed lines, and so in accordance with the generally accepted theories of designers, that there has been little to say. More recently, however, in order to keep pace with the times and to cope with the necessity we have always before us of securing ships that will be in nowise inferior of those built for any other nations, a change in machinery design has been made that at first glance appears radical—the general adoption of water tube boilers for all new vessels of our Navy.

Elsewhere violent diatribes have been launched against those responsible for a similar decision, and I am aware that there exists a not inconsiderable sentiment in this country against water tube boilers. I call it a sentiment advisedly, because I believe that much of it is due to the attachment that engineers have for their old and proved friend, the cylindrical boiler.

Only a part of the opinions unfavorable to the change arises from the natural and proper conservatism of naval architects and marine engineers, but these demand answer. Flooded always with new devices—or, rather, by rejuvenated failures in new forms—we find a very small proportion that is even worthy of a trial; and where a new mechanical idea is tried on shipboard so much time is spent in adapting it to naval conditions and in repairing its failures that each of us becomes naturally and properly dubious when any change is suggested. Any important change in design, even of the apparently minor fittings of ships, may involve such risk to vessel and crew as to be unjustifiable, unless the device be thoroughly tried beforehand. Many apparently good ideas have given successful results on shore only to fail dismally at sea. I think that it may be given as a general rule that no change in design should be authorized that has not already been successfully made.

Of course, a strict application of the foregoing rule would lead to stagnation. Here, however, enters the designer. His role is an important one. He has to cull the good points from previous work, and if he be a good designer he must also leave out the bad points. There always are some bad points, but amelioration of conditions should be the aim of naval designers. This implies that a good designer must be of vast experience and of extended observation. The larger his field of observation the more valuable his conclusions. It is the details that count. No man can succeed as a designer of warships without the most careful attention to small things.

The modern battleship is a monument to the greatness of the minutiæ of design. It has been gradually built up from the sailing beauties of a century ago. Steps in advance have been slow, generally speaking. We cannot advance by leaps and bounds in marine work. Here genius is hampered by such conditions as make any step in advance a great achievement. Of course, we

* Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.

have the case of Ericsson and the *Monitor*, but this was a case not only of special conditions, but also of a most exceptional man. Naval architecture is a pyramid, each stone of which is supported by all of the preceding ones. The size of the stone that one man can add to the pile depends, of course, upon his ability, but more especially upon his work. By hard work and by paying attention to what is going on around him any man can add his quota; but "those who, having eyes, see not; and who, having ears, hear not," are worse than useless.

The task I have set myself to-day is no mean one. I desire to show that the decision to use nothing but water tube boilers in our future war vessels is a step in advance, and that it is a natural step towards the evolution of the perfect fighting machine. I desire to show that it is no radical change, and that it does not involve the use of anything but a tried, successful and reliable apparatus that gives us positive and great advantages over the character of boilers heretofore generally used. I desire not to minimize the disadvantages following this change, but to show that these disadvantages are not only not insurmountable, but for warships they have already been overcome.

In the first place, I want to state that water tube boilers are bad in principle. They carry the pressure inside their weakest parts—the tubes. A failure in a tube is followed by the opening of a fault, sometimes to a dangerous degree. In a fire tube boiler, on the contrary, the pressure would continue to close a split tube. It is true that a failure of a boiler tube generally comes from pitting, where fire tube boilers generally have such a great advantage as in cases of split tubes. Yet failure of tubes is the most common defect in all boilers, and a proper design would place the pressure on the outside of the tube. Water tube boilers are, from their very definition, designed from a wrong principle, not only because of the direction of application of pressure upon the tubes, but also on account of the decreased amount of water in the boiler, of the increased difficulty of observing a leak, and of the decreased value of heating surface in water tube boilers. For this reason, as an engineer, it is with some misgiving that I state that I consider water tube boilers tactical necessities for warships.

Builders of water tube boilers use solid-drawn tubes almost exclusively for marine work. This, of course, decreases the danger of split tubes, but it does not change the mechanical principle. Some day, probably not in my time, we may hope to have a boiler having fire tubes and having the advantages of water tube boilers. Such a boiler would force its way at once into all navies, just as water tube boilers are doing at the present day.

Disbelieving, as I do, in the cardinal principles of water tube boilers, I have sturdily opposed their adoption by our Navy, until now I am convinced that they must be used if we are not going to content ourselves with inferior ships to those built for other nations. Of course, during the period of development of the design of water tube boilers, that even now continues, I have in my official capacity kept track of and taken part in the world-wide experiments with their use. Water tube boilers have advantages, and I have never been blind to them. Two years ago I stated that their disadvantages had been sufficiently removed to justify their use on our warships. Now I consider that the value of their advantages has been sufficiently developed to necessitate their use, if we do not wish to be left behind in naval design.

The principal thing to which I desire to call your attention is the fact that all vessels are essentially compromises. Any ship must be considered in its entirety, and the advisability of a change in design of any part must be determined from its effect upon the ship as a whole. Whether or not water tube boilers are superior to cylindrical boilers as boilers simply, if there be a beneficial effect upon the ship as a whole due to the adoption of water tube boilers, these boilers are essential to the best design.

The necessity of compromise in ship design must be self-evident to the members of this Society, who have the problem before them for solution almost daily. Taking the particular case of warships, the size of our ships is limited by their draft. We are building vessels now that are as large as any that can enter our harbors and docks, and we cannot, therefore, increase their power as fighting ships except by improvements in design. Any increase in weight allotted to one essential of the efficiency of the ship must be counter-balanced by a decrease in some other perhaps equally essential element. So far this has most frequently been done by robbing the coal pile—an extra gun, a half knot in speed, or an additional inch in armor protection—each mean a few tons less coal in the bunkers. I must except the more recent designs of battleships from the above general rules. The importance of coal endurance has become more and more manifest, and it has been appreciated fully in our recent designs. Incidentally, these last ships are fitted with water tube boilers.

Water tube boilers are considerably lighter than those of the old type, and their effect upon ship design may be given as follows: Of two ships having all other qualities identical, one fitted with cylindrical boilers and the other with water tube boilers, the latter will be somewhat the smaller and handier—will have somewhat less draught, and will cost less.

Limited, as we are, in the size of our warships by their draught, I think that the foregoing shows that for a maximum of fighting efficiency we must use water tube boilers. The designing engineers of our naval vessels are limited in weight and space. They save little or nothing in space, perhaps, but they save greatly in weight if they adopt water tube boilers. If these can be successfully operated on shipboard they must be used because of their decreased weight. The foregoing is entirely apart from any consideration of the relative merits of water tube and fire tube boilers, but it is conditional upon the possibility of the successful operation of water tube boilers.

Before considering claimed advantages and disadvantages of water tube boilers, I desire to give a few historical facts, most of them already well known to the members of this Society.

The old Martin boiler was the first water tube boiler ever used in any naval vessel. We had good success with these boilers, but they died out of use with the introduction of high-pressure multiple-expansion engines, and the consequent cylindrical boilers.

For years none but water tube boilers have been in-

stalled in our steam launches. These have always been attended by unskilled labor, yet the results have been very satisfactory. Some accidents have occurred, but they have been very few, probably no greater in number than if fire tube boilers had been used; and it is to be noted that the results of a boiler explosion would probably have been worse in almost every case if the failure had occurred in a fire tube boiler.

Torpedo-boats and destroyers in our Navy have always, since the time of the *Cushing*, been equipped with water tube boilers of various types. Small bent tube boilers have generally been used. There have been some cases of sad accidents in the fire-rooms, generally due to carelessness in manufacture, and particularly in tube setting, but not to defective design. The boilers have proved to be quite as reliable as the extremely light engines of these boats. With the small amount of skilled attention it is possible to give torpedo-boats, and considering the character of service demanded of these small craft, I think that no engineer will to-day question that the use of light water tube boilers, with the higher speeds possible as a result, adds to their efficiency and security. I think even Herr Schichau has come to be of this opinion.

The first large installation of water tube boilers in our Navy was on the *Monterey*. Indeed, at the time this was the largest installation of water tube boilers in any navy. In this monitor, as you all know, there are four round Ward water tube boilers, with two cylindrical single-ended fire tube boilers. The water tube boilers have been satisfactory. It is worthy of note that there has been very little difficulty experienced in maintaining a steady water level, although the boilers have a very small amount of contained water. Tubes have failed by pitting several times, though never with any danger to the firemen. The water tube boilers have been twice retubed by the ship's force without laying the ship up at any navy yard. On one occasion, probably with a view to thoroughly testing the water tube boilers, or to satisfy the unholy desires of some person decrying water tube boilers, the ship made a voyage of about 8,000 knots, largely under forced draught, and whenever possible with all boilers in use. There was no resultant injury to the water tube boilers, which performed well throughout the trial. The combustion chambers of the cylindrical boilers came out of the trial badly bulged.

The Yarrow boilers of the *Nashville* have operated fairly successfully, though they cannot be said to be completely satisfactory, on account of the amount of trouble given by bulging of drums and by leaky tubes. The first set of copper tubes has been replaced by others of steel to considerable advantage. I believe that the latest designs of this type of boiler provide for the use of slightly curved tubes next the fire. This ought to be advantageous.

The *Marietta's* trip around South America at the beginning of the war with Spain was quite as successful as was that of the Oregon. The first ship is fitted with Babcock & Wilcox boilers, the second with cylindrical boilers. No repairs were required to either set of boilers after the completion of the trip.

The *Annapolis* is also equipped with Babcock & Wilcox boilers, and here, as on the *Marietta*, these boilers have been thoroughly successful. Indeed, a former chief engineer of the *Annapolis* has stated to me that the boilers of that ship were easier to manage in use and easier to maintain in a state of high efficiency than are cylindrical boilers.

The *Chicago* has several Babcock & Wilcox boilers, and these have so far worked in a thoroughly satisfactory manner, no failure being reported under any circumstances.

The foregoing represents the tried installations of water tube boilers in ships larger than torpedo-boats and destroyers in the United States Navy. Babcock & Wilcox boilers of the shore or stationary type were installed in the old monitors *Canonicus*, *Mahopac*, and *Manhattan*, the old rectangular boilers being entirely worn out and it being deemed advisable to fit these old boats for whatever service they could do. The change was commenced at the beginning of the Spanish war. Before its close the change was complete, and a somewhat greater speed was attained than with the original boilers. This change was made without injuring the decks of the monitors. The old boilers were cut up and passed out through the smokestack, down which the parts of the new boilers were passed, the latter being assembled in the engine-room space. This is an instance where none but water tube boilers could have been used, and where every facility of repair and installation was of enormous advantage. For naval vessels with their protective decks the facility with which water tube boilers can be removed or completely renewed without disturbing the decks may of itself justify us in adopting water tube boilers.

There are building and repairing several other ships of our Navy, to be fitted with partial or complete outfits of water tube boilers. These include the *Alert*, *Atlanta*, *Cincinnati*, *Wyoming* (Babcock & Wilcox), *Maine* and *Connecticut* (Niclausse), *Missouri*, *Wisconsin*, and *Arkansas* (Thornycroft), and *Florida* (modified Normand).

The foregoing gives the installation of water tube boilers in our Navy from which data has been obtained. So far as tried, the boilers have invariably been easy of operation, though I have found more skill required to obtain the best results from these boilers than would have been necessary if cylindrical boilers had been used. Particular attention has been given in all cases to the feed arrangements. Water tube boilers must have ample feed pumps, and the regulation of the feed must be easy. At first the heating surface of water tube boilers was made 3 sq. ft. per horse power, against 2 sq. ft. necessary with cylindrical boilers. This figure has been gradually reduced, until now we are down to 2.4 sq. ft. of heating surface per horse power, about as low as I think it is yet safe to go with water tube boilers.

The economical results from water tube boilers were at first not particularly good. At present we get quite as good results from water tube boilers of the latest design as from the best cylindrical boilers. The ratio of heating surface to grate surface has been kept up to at least 40, although we do not yet feel warranted in allowing as small grate surfaces in water tube boilers as in cylindrical boilers. Water tube boilers lose in efficiency when forced, especially those of the straight-tube type. Of course, this is not of very great moment to us, in a naval vessel, which is under forced draught only at

maximum speed, but it is, nevertheless, a disadvantage.

The following table shows the relative economy of cylindrical and water tube boilers:

	Annapolis.	Marietta.	Newport.	Princeton.	Vicks-burg.	Wheeling.
Type and number of boilers....	(2 B. & W.)		(2 single-ended cylindrical.)			
Displacement (tons)	1,000	1,000	1 000	1,000	1,c00	1,000
Knots per ton of coal at most economical speed..........	26.38	22.27	18	19.6	21.25	16.6
Number of scr'ws	1	2	1	1	1	2
Grate surface (sq. ft.)......	98	94	78	78	78	60
Heating surface (sq. ft.)..........	3,620	3,664	2,524	2,524	2,524	2,508

The increased grate surface we have required with water tube boilers will be a positive advantage to our ships' steaming qualities. I consider that sustained sea speed depends largely upon the grate surface. Heating surface, of course, must be provided, but I should prefer an excess of grate surface to an exceedingly high ratio of heating surface to grate.

Up to this time we have had no trouble from salt water or grease in water tube boilers. Indeed, we could hardly be more troubled by salt water with this type of boiler than we have been with cylindrical boilers. We suffered severely in our short war with Spain from dropped furnaces in cylindrical boilers. I do not think that a properly designed water tube boiler will give more trouble from the use of impure feed water, such as sometimes we must have at sea, than any other boiler. I do not think tubes more liable than furnaces to fail from a deposit of scale. In any event, the evaporating plants of all our ships are being made adequate to give fresh feed water. The only danger of salt water in the future should come from leaky condensers.

Glancing abroad for a moment, we find every modern naval power, from England to Japan, committed to the use of water tube boilers on the largest scale. Each of these countries has had its experience, and each has decided not only that water tube boilers can be worked, but also that they work well and that they must be used in naval vessels.

I will give a few observations on the working of various types of water tube boilers abroad. The result of a first glance would seem to be that anything would do to make steam, from Watt's tea-kettle to the most complicated of modern steam generators. I know of one French boiler (you know what ingenious mechanics the French are) composed equally of water and fire tubes. The tubes were concentric, and the distance between them but one millimeter. Of course, the amount of water is very small—so small as to put this boiler in the class called by their originators "inexplosible." This boiler was tried at the works of the maker with good results. It was next tried in a torpedo-boat with equally remarkable results—seven men killed, I believe.

We have read of explosions, however, of really well-designed water tube boilers. Generally it is found that a tube had failed, and that the furnace door was open—the result, more or less fatal burns to all in the fire-room. We hear of all the failures, but the successes are never mentioned. It is not difficult to foresee the failure of a boiler plant designed to furnish 120,000 pounds of steam per hour, but regularly required to furnish 160,000 pounds per hour. If nothing else fails, the feed pumps will not do the work, and the tubes will, of course, be burnt out. This would happen with any type of boiler.

You see, I harp on the failures, for I find I can glean the most information from them. Many of the failures have come from the use of boilers that were inaccessible for cleaning and repairs; others from faultv design; others from poor workmanship; others, again, from neglect. Water tube boilers require skilled attendance. Other boilers have failed from poor material; others from failure of the feed pumps; but there is not one, so far as I know, that can properly be said to have failed purely as a result of being a water tube boiler. Failures may come from misusing water tube boilers, but not from using them. I consider that the experience of the last ten years or more in our own and in foreign navies justifies me in stating that water tube boilers, when proper precautions are used, can be successfully adopted for the steam generating plant of ocean-going vessels. They are necessities to the best design of warships.

I would naturally come now to a discussion of the claims of the adherents and opponents of water tube boilers. You have all heard these arguments, and it seems almost useless to go over them. I shall simply state what I believe to be the advantages and disadvantages of water tube boilers compared with cylindrical boilers:

Advantages.	Disadvantages.
Less weight of water.	Greater danger from failure of tubes.
Quicker steamers.	Better feed arrangements necessary.
Quicker response to change in amount of steam required.	Greater skill required in management.
Greater freedom of expansion.	Units too small.
Higher cruising speed.	Greater grate surface and heating surface required.
More perfect circulation.	Less reserve in form of water in boiler.
Adaptability to high pressures.	Large number of parts.
Smaller steam pipes and fittings.	Tubes difficult of access.
Greater ease of repair.	Large number of joints.
Greater ease of installation.	More danger of priming.
Greater elasticity of design.	
Less danger from explosion.	

A saving in space has been claimed for water tube boilers, but I do not find this claim sound when account is taken of the increase in grate and heating surface necessary in water tube boilers to ensure satisfactory working, and because of small units the space for accessibility is increased rather than diminished.

The fact that water tube boilers raise steam quickly is of the greatest advantage. I have stated elsewhere that I consider the battle of Santiago to have developed the necessity of the use of water tube boilers whether it taught us anything else or not. It would have been of the greatest advantage to have had during the blockade of Santiago boilers capable of raising steam in less than half an hour. Coal need not have been used to keep all the boilers under steam all the time. The *Massachusetts* might have shared in the glories of the fight if she had been fitted with water tube boilers. The *Indiana* would have kept up with the *Oregon* and the *Texas*. The *New York* would have developed at least three knots more speed, and the Navy would have been spared a controversy. I think the

Colon would not have gotten as far away as she did. But we did not have the water tube boilers.

The higher pressures possible with water tube boilers give us smaller and safe steam pipes and better valves. It decreases the size of the fittings and the difficulty of tracing the labyrinth of a ship's piping. It increases the efficiency of the engines. The introduction of compound engines forced us to use cylindrical boilers. In the same way the use of quadruple expansion engines necessitates, for economy, the use of water tube boilers.

But the quick steam raiser is, because of that very fact, not so safe as its predecessor. Of course, nothing on a man-of-war is very safe in war time, but we want things as safe as possible, and the boilers are the keys to the situation in the modern battleship. I think that safety in handling water tube boilers may be assured by using skill in the fire-rooms. I have more than ten years' successful experience with water tube boilers on which to found this opinion, and I submit that the boilers, placed as they are behind the heaviest armor and below the thick protective deck, are, at the worst, the safest apparatus on a battleship. If we can make them work well we would do wrong to refuse to use water tube boilers on our ships.

For merchant and for yacht practice it is a different question. I was recently asked what boilers to use in a large steam yacht. I recommended cylindrical boilers. For merchant work the boilers are always in use, developing a fixed power. Weight is not there so important as in warships, and I think it is at best a moot question whether cylindrical boilers are not still the best that can be fitted in ocean-going merchantmen. In some cases where there are short trips and the opportunities for repair must be gotten during the very short lay-ups at the end of the route, the quick steam raising qualities of water tube boilers, with their freedom of expansion, enables blowing down the boiler immediately on arrival in port and still having steam at an hour's notice on all boilers. Such cases as this seem to me to demand water tube boilers.

As to the type of boiler to be used there are as many to choose from as there are fleas on a dog. Some one has said that a certain amount of fleas keep a dog from brooding over being a dog. So the number of varieties we have to choose from may be a good thing for all.

I have always opposed the use of boilers containing screw joints in contact with the fire, and have attempted to secure boilers having no cast metal in the pressure parts. Cast steel is not yet good enough to put between 300 pounds of steam and our firemen. I believe in straight-tube boilers, as being easier of examination and repair than bent-tube boilers. I believe in large tube boilers for the same reason, and because the tubes are thicker and have more margin for corrosion. I believe in boilers having as few joints as possible. Water tube boilers must have freedom of expansion of the various parts, and the simpler the boiler the better. It should not be necessary to introduce reducing valves between the boilers and the engines to secure a steady steam pressure at the latter, nor should it be necessary to have automatic feed arrangements to ensure steady water level in the boilers. To be successful a boiler must be easy of repair. Lightness is a natural attribute of all water tube boilers, but it is not wise to go too far in this direction. The ratio of grate surface to fire surface occupied for the complete boiler plant must be as large as possible. The units should be large, the grates short and not too wide. The passage of gases through the tubes should be sufficiently long to ensure economy. These gases should be well mixed before entering the spaces between the tubes for the same reason, and to prevent smoke. The circulation of the water in the boiler must be free. Tubes should not be too long, and the fire-rooms must always be sufficiently wide to provide for free withdrawal.

The foregoing is what we want. We have most of the above desiderata in several well-known types of boilers and ultimately we shall discover the value of each of the foregoing points, and then it will be possible to differentiate between the various types more perfectly than we now can.

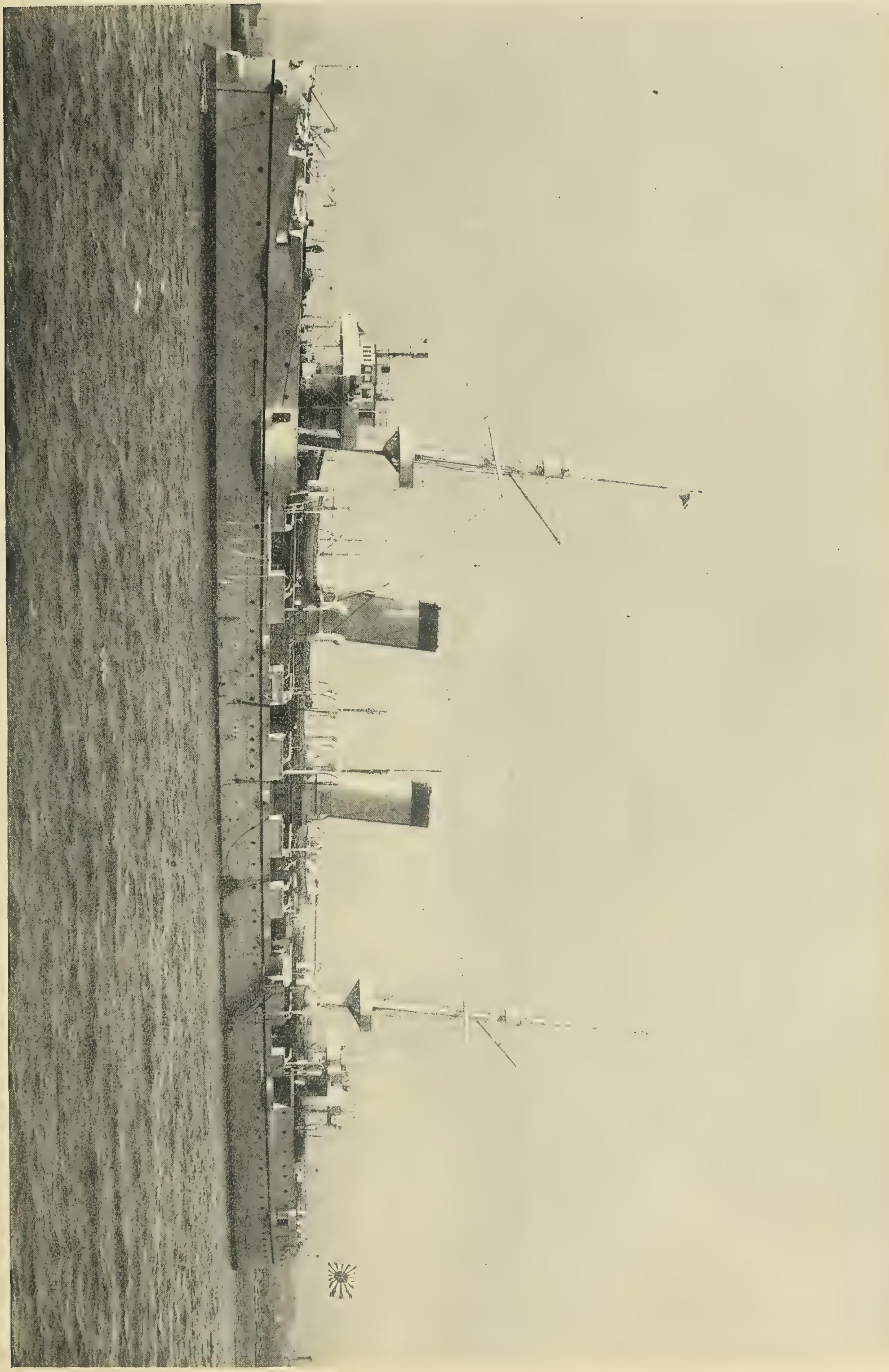
In the meantime, all that I have to say is that the use of water tube boilers has been definitely decided upon for our naval vessels, because water tube boilers give tactical advantages of great moment, and because, with care in selection, manufacture and management of water tube boilers, other disadvantages may be neutralized.

Japanese Cruiser Chitose.

On the opposite page we give a view of the Japanese cruiser *Chitose*, built by the Union Iron Works, San Francisco, and which has recently successfully undergone her acceptance trials in Japanese waters. The results have been highly satisfactory, as on the trial an average speed of 21.5 knots (natural draft) was maintained ,while the contract called for a rate of speed one knot less. Under the terms of the contract, we are informed, the acceptance of the vessel by the Japanese Government was not to take place until March next, but the naval officers reported so favorably on the *Chitose* that she has been accepted and the final payments made to the builders. The *Chitose* is therefore now in commission attached to the Japanese home squadron.

The *Chitose* is a steel protected cruiser of these dimensions: Length, 376 ft. 5 in.; beam, 49 ft., and draft, normal, 17 ft. 7 in., with a displacement of about 4,700 tons. She is fitted with twin screws driven by triple expansion engines of 15,500 I. H. P.—maximum. Steam is supplied by cylindrical return tube boilers, four double ended and four single ended. She has a protected deck of 4 1-2 in. maximum thickness. Her armament, which was supplied by the Armstrong's and was fitted in place in Japan, consists of two 8-in. guns, one forward and one aft, protected by shields; ten 4.7-in. guns, twelve 12-pounders, twelve 6-pounders, and six 1-pounder. All are of the rapid fire pattern. She has also five torpedo tubes. Her cost complete was about $1,500,000. A sister ship, the *Kasagi*, was built by the Cramp's for the Japanese navy.

Quick work was done on the British battleship *Venerable* launched recently, the vessel having been launched just eight months from the time she was laid down at Chatham Dock Yard. Her launching weight was 5,200 tons. The vessel when completed will displace 15,000 tons and will have a trial speed of 18 knots. Her armament will consist of four 12-in., twelve 6-in., sixteen 12-pounders and a number of machine and small guns.



JAPANESE PROTECTED CRUISER CHITOSE—4,700 TONS, 15,500 I. H. P.—BUILT AND ENGINED BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.

CONSIDERATION OF THE STEAM YACHT FROM THE DESIGNER'S POINT OF VIEW.—III.

BY WILLIAM A. FAIRBURN.

In general appearance the steam yacht of to-day still resembles somewhat the yacht of twelve or more years ago. The earlier yachts, however, were fitted with a single deck house forward and later with two houses, one forward and one aft, with low machinery casings amidship. A large number of British yachts had their solitary house nearer amidships and this was often connected to the machinery casings. About 1893 one large deck house running over half the length of the vessel began to take the place of the small and separate deck houses. The *Eleanor* was the first large steam yacht which had this feature. A year later the *Giralda* appeared with a similar deck house, but the top of the house ran out to the side of the vessel, thus forming a shade deck and a most desirable promenade above. The *Giralda* was also the first yacht to be fitted with a topgallant forecastle. The latest Watson designed boats instead of having the usual deck house with a passage between it and the rail, have the deck house extending out to the side, thus forming a continuation of the shell of the vessel. By this arrangement splendid accommodation is obtained on the main deck. It is, however, questionable as to which arrangement of deck houses is preferable: The Watson *Mayflower* style, or the British *Giralda* and American *Aphrodite* style, in which there is a deck space of about 6 ft. between the rail and the house on either side. While the latter arrangement somehow narrows the rooms, it has the compensating advantage of a clear view forward from the quarter deck the length of the ship, instead of a vista of deck houses. It also gives an unbroken promenade from stem to stern and, as the top of the deck house runs out to the side of the vessel, there is still the spacious unbroken promenade above. If the yachtsman desires his vessel for cruising, deep sea work and genuine yachting, he would probably prefer the latter arrangement; but if for coasting, receptions and social functions, the latest Watson arrangement would undoubtedly please him the most.

Considerable controversy has appeared of late in a few yachting papers, criticizing the general appearance of various American steam yachts. The writer will not here make any plea for American designed and built yachts, but he will say, and this most forcibly, that there are men in America to-day capable of designing steam yachts which, in appearance, accommodation and seagoing qualities, will be equal to the best production of foreign designers. It is about time for the patriotism of American yachtsmen to assert itself so that we can build American designed steam yachts for American owners.

Many yachts on both sides of the Atlantic could without doubt be classed as failures. The design of a steam yacht by the majority of shipbuilding firms is not given the strict attention and careful consideration which it is entitled to, and that is why there are so many naval architects to-day who make a specialty of yacht design. The most skilful naval architect cannot design a truly handsome, successful, steam yacht if he is not thoroughly in sympathy with his work. He needs to be schooled to the work. His judgment must be good and his taste such that all the lines of the vessel harmonize with each other. Many a pleasure craft today has graceful endings—bow and stern—very pleasing to the eye when viewed separately, but when placed on the same vessel they lack harmony and fail to balance. The combination of the sheer, bow and stern is generally what determines the appearance of the yacht, but much also depends on location and rake of spars, stack, etc., and the arrangement of the deck work.

On a steam yacht much has to be sacrificed in order to get a fine appearance. All private owned steam yachts afloat to-day possess but one smokestack or funnel, and the latest fad of yacht owners is to make this elliptical and as "powerful" looking as possible. The earliest full powered yachts had a schooner rig with standing gaffs. Now the British vessels are usually supplied with fitted topmasts, sliding French gaffs, bowsprit and jibboom; whilst the American vessels which have no pretense of sail power are fitted with pole masts, French sliding gaffs and spike bowsprits. Pole masts with leg of mutton sails are gaining in popularity. The French gaffs are always carried low, only just high enough to clear the awnings and being peaked they are very pleasing to the eye. A single yard on the foremast is also peculiar to British designed steam yachts. The early auxiliary steam yachts had a fore and aft schooner rig, and they have been through all the stages of barkentine, brigantine, barque and brig, to the full ship rig.

Although quite a large number of the yachts afloat to-day have the owner's accommodation on the lower deck forward, yet the modern practice is to place the owner and his guests aft, and give the forward lower deck to the officers and crew. Sometimes the owner and his guests are given the best of the space both forward and aft of the machinery spaces. When this is the case the officers are located aft and the crew forward—an arrangement that has many advantages. The deck house on the large vessels is usually divided up into reception room, dining room, owner's private rooms, galley pantry, laundry and machinery casings. The latest boats have a large chart room, captain's stateroom and smoking room above the deck house on the shade deck, and the top of this house forms a bridge running out to the side of the ship.

From the foregoing one might be given the impression that steam yachts are designed principally for appearance and accommodation. This to a great extent is true, but the all-important matter of seaworthiness and easiness in a seaway is of vital importance. Modern sea going yachts are being given great flare to the bow above water and good freeboard. Bilge keels are also beginning to be adopted. The *Aphrodite* is practically a non-roller, she having bilge keels with an area of about 280 sq. ft. each. Many persons have the impression that a steam yacht necessarily means a vessel of light scantlings, but this is not the case, for whilst small craft of high speed have of necessity light scantlings bordering on torpedo boat construction, yet ocean going yachts to be insured must be classed by one of the standard registration societies, of which the best known are probably the British Lloyd's, Bureau Veritas, and the American Bureau of Shipping. These societies have until recently insisted on scantlings for

large yachts as heavy as put into merchant vessels of the same dimensions. For instance, many a sea going steam yacht has been built according to the American Bureau or U. S. Standard rules, with scantlings as heavy as required for a cargo steamer of the same outside dimensions, but almost twice the displacement, and yet the steam yacht possesses a much superior shape when viewed from a strength standpoint. She has a natural, strong, easy shape. Lloyd's allow somewhat for this difference, as they consider the girth of the midship section—as will also the new 1900 rules of the American Bureau of Shipping—but it must be acknowledged that the ocean going steam yachts are about the strongest vessels afloat, especially if the classification societies allow the designer to judiciously arrange some of the material so as to get maximum efficiency with the weight allowed.

Much has been said, especially of late, concerning the steam yacht as a naval auxiliary. In time of war the full powered steam yacht will undoubtedly prove an acquisition to the Navy, acting as a dispatch and special service vessel. Some of the converted steam yachts did good work off Cuba in the late war. The high speed yacht built for sound and coast work has been, and may continue to be, a very popular vessel in America, and these vessels having fair accommodations, high speed, light draft, good manœuvring qualities and ability to rapidly get up steam, could probably with little expense be converted into torpedo or patrol vessels in case of an emergency, provided they are not too small; for the general dimensions, the model, and the motive power, are about the same for the fast yacht as for the torpedo boat. Nevertheless, well designed pleasure yachts will not make first-class war vessels and these vessels should only be thought of as auxiliaries, being used only when war vessels cannot be procured.

The cost of a steam yacht is a very variable quantity, as fully 40 per cent of the cost may be due to the owner's whims and fancies in selecting magnificent furnishings for his yacht. But few people have any conception of the cost of a steam yacht. Even a little steam or naptha launch costs from $1,000 to $5,000. A small steam yacht like the *Oberon* costs about $7,000, and this vessel is no larger than many a launch. A yacht fit for fair weather coasting is very cheap at $18,000, and the majority of this class exceed this figure by a good deal. It is said that the *Illawarra*, 106 ft. long and 12 knots speed, cost about $60,000; the *Free Lance*, 108 ft. long and 16 knots, $65,000; the *Peregrine*, 131 ft. long and 14 knots, $95,000; the *Electra*, $125,000; and the builders of the *Atalanta*, *Eleanor* and *Corsair* received about $200,000 each for the construction of these vessels. It is said John Jacob Astor paid $240,000 for the *Nourmahal*; the *Varuna* cost Eugene Higgins about $300,000, and the *Aphrodite* yacht has cost Col. Payne $360,000. These prices are for the boats complete, with the exception of the fittings and furnishings and equipment furnished by the owner. The largest yachts afloat to-day are probably worth from $400,000 to $600,000 complete, with all furnishings on board. But initial cost is not all that must be considered, for it costs a fortune every year to keep any of these large pleasure craft in commission, the running expenses of the larger vessels varying from $8,000 to $15,000 per month, and sometimes when there is much entertaining even more.

Year by year larger and finer steam yachts are being constructed. As we study the magnificent vessels afloat to-day it seems as if the limit of size and excellence of design has been reached. But this is not so, for progress must yet be made, and even to-day designers must confess that their productions are not perfect—they are the best that could be produced under existing conditions. The adoption of water tube boilers in ocean going vessels, before many years, will greatly assist the yacht designer, for it is in the machinery and propulsion of these vessels that there is the greatest room for improvement. Nevertheless, the modern steam yacht is an artistic, mechanical and practical production, and worthy of the admiration and approbation of all interested in Naval Architecture and Marine Engineering.

Obituary.

Commander Charles P. Howell, who was chief engineer of the battleship *Maine* when she was blown up in Havana harbor February 15, 1898, died at his residence in New York, December 7. He expired suddenly from an apoplectic stroke. Commander Howell was born in Goshen, N. Y., fifty years ago, and he was graduated from the Naval Academy in June, 1868, fourth in his class. He had attained the rank of chief engineer under the old organization and under the operation of the Personnel Bill was made a commander in September last. At the time of his death Commander Howell was on duty at the New York Navy Yard. The funeral was carried out with military honors, the Reverend Doctor McKelway, chaplain of the training ship *Vermont*, officiating. The Episcopal Church service was used. The interment took place at Goshen, N. Y.

About the time of our going to press last month the death of Thomas H. Ismay was announced. Mr. Ismay was widely known as the founder and chairman of the White Star line. When he first became identified with that line it consisted entirely of sailing ships in the Australian trade, but when transatlantic trade was decided upon an order for a steamship, the original *Oceanic* was placed with Harland and Wolff, at Belfast. These builders have constructed the entire fleet of the White Star line; and such were the relations between Mr. Ismay and others in the management of the White Star line and the firm of Harland and Wolff, that no contract was ever made between them for the construction of any of these vessels. Under Mr. Ismay's directions the company expended about $35,000,000 in steamships since the early seventies. Mr. Ismay resided in Liverpool and was identified with many public enterprises.

Dixon Kemp, the famous English authority on yachts and yachting, died recently in England, aged sixty years. Mr. Kemp was largely responsible for the establishment of Lloyds yacht register and for many years he was the yachting editor of the English publication known as the *Field*.

Reverend E. L. Berthon died recently in England at an advanced age. He was best known as the inventor of the collapsible boat which bore his name, though he was the inventor of a variety of devices, some for marine use.

REVIEW OF PAST PROGRESS IN STEAM NAVIGATION AND FORECAST OF FUTURE DEVELOPMENT.*—II.

BY SIR WILLIAM WHITE, CONSTRUCTOR-IN-CHIEF, R. N.

ADVANTAGES OF INCREASED DIMENSIONS.

Before passing on it may be interesting to illustrate the gain in economy of propulsion resulting from increase in dimensions by means of the following table, which gives particulars of a number of typical cruisers, all of compartively recent design:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Length, feet	280	300	360	435	500
Breadth, feet	35	43	60	69	71
Mean draught, feet	13	16½	23¾	24½	26¼
Displacement, tons	1,800	3,400	7,400	11,000	14,200
Indicated horse-power for 20 knots	6,000	9,000	11,000	14,000	15,500
Indicated horse-power per ton of displacement	3.3	2.65	1.48	1.27	1.09

The figures given are the results of actual trials, and embody, therefore, the efficiencies of propelling machinery, propellers and forms of the individual ships. Even so they are instructive. Comparing the first and last, for example, it will be seen that while the displacement is increased nearly eightfold, the power for 20 knots is only increased about 2.6 times. If the same types of engines and boilers had been adopted in these two vessels—which was not the case, of course—the weights of propelling apparatus and coal for a given distance would have been proportional to the respective powers; that is to say, the larger vessel would have been equipped with only 2.6 times the weight carried by the smaller. On the other hand, roughly speaking, the disposable weights, after providing for hulls and fittings in these two vessels, might be considered to be proportional to their displacements. As a matter of fact this assumption is distinctly in favor of the smaller ship. Adopting it, the larger vessel would have about eight times the disposable weight of the smaller; while the demand for propelling apparatus and fuel would be only 2.6 times that of the smaller vessel. There would, therefore, be an enormous margin of carrying power in comparison with displacement in the larger vessel. This might be devoted, and in fact was devoted, partly to the attainment of a speed considerably exceeding 20 knots—which was a maximum for the smaller vessel—partly to increased coal endurance, and partly to protection and armament.

Another interesting comparison may be made between vessels Nos. 4 and 5 in the preceding table, by tracing the growth in power necessary to drive the vessels at speeds ranging from 10 knots up to 22 knots:

Knots.	No. 4. Horse-power.	No. 5. Horse-power.
10	1,500	1,800
12	2,500	3,100
14	4,000	5,000
16	6,000	7,500
18	9,000	11,000
20	14,000	15,500
22	23,000	23,000

It will be noted that up to the speed of 18 knots there is a fairly constant ratio between the powers required to drive the two ships. As the speeds are increased the larger ship gains, and at 22 knots the same power is required in both ships. The smaller vessel, as a matter of fact, was designed for a maximum speed of 20 1-2 knots, and the larger for 22 knots. Unless other qualities had been sacrificed neither space nor weight could have been found in the smaller vessel for machinery and coals corresponding to 22 knots. The figures are interesting, however, as illustrations of the principle that economy of propulsion is favored by increase in dimensions as speeds are raised.

Going a step further, it may be assumed that in unsheathed cruisers of this class about 40 per cent of the displacement will be required for the hull and fittings, so that the balance, or "disposable weight," would be about 60 per cent, say 6,600 tons for the smaller vessel, and 8,500 tons for the larger, a gain of nearly 2,000 tons for the latter. If the speed of 22 knots were secured in both ships, with machinery and boilers of the same type, the larger ship would, therefore, have about 2,000 tons greater weight available for coals, armament, armor and equipment.

These illustrations of well-known principles have been given simply for the assistance of those not familiar with the subject, and they need not be carried further. More general treatment of the subject based on experimental and theoretical investigation will be found in text-books of naval architecture, but would be out of place in this address.

SWIFT TORPEDO VESSELS.

Torpedo flotillas are comparatively recent additions to war fleets. The first torpedo boat was built by Mr. Thornycroft for the Norwegian navy in 1873, and the same gentleman built the first torpedo boat for the royal navy in 1877. The construction of the larger class, known as "torpedo boat destroyers," dates from 1893. These various classes furnish some of the most notable examples extant of the attainment of extraordinarily high speeds for short periods, and in smooth water, by vessels of small dimensions. Their qualities and performances, therefore, merit examination. Mr. Thornycroft may justly be considered the pioneer in this class of work. Greatly impressed by the combination of lightness and power embodied in railway locomotives, Mr. Thornycroft applied similar principles to the propulsion of small boats, and obtained remarkably high speeds. His work became more widely known when the results were published of a series of trials, conducted in 1872 by Sir Frederick Bramwell, on a small vessel named the *Miranda*. She was only 45 ft. long, and weighed four tons, yet she exceeded 16 knots on trial. The Norwegian torpedo boat, built in 1873, was 57 ft. long, 7 1-2 tons, and of 15 knots; the first English torpedo boat of 1877 was 81 ft. long, 29 tons, and attained 18 1-2 knots. Mr. Yarrow also undertook the construction of small swift vessels at a very early date, and has greatly distinguished himself throughout the development of the torpedo flotilla. Messrs. White, of Cowes, previously well known as builders of steamboats for use on board ships, extended their operations to the construction of torpedo boats. These three firms for a considerable time practically monopolized this special class of work in this country. Abroad they had able competitors in Normand in France, Schichau in Germany, and Herreshoff in the United States. Keen competition led to successive improvements, and rapid rise in speed.

During the last six years the demand for a fleet of about one hundred destroyers, to be built in the short-

*From a paper read before the British Association, Mechanical Science Section.

est possible time, involved the necessity for increasing the sources of supply. At the invitation of the Admiralty a considerable number of the leading shipbuilding and engineering firms have undertaken, and successfully carried through, the construction of destroyers varying from 26 to 33 knots in speed, although the work was necessarily of a novel character, involving many difficulties. As the speeds of torpedo vessels have risen, so have their dimensions increased.

Within the class, the law shown to hold good in larger vessels applies equally. In 1877 a first-class torpedo boat was 81 ft. long, under 30 tons weight, developed 400 horse power, and steamed 18 1-2 knots. Ten years later the corresponding class of boat was 135 ft. long, 125 tons weight, developed 1,500 horse power, and steamed 23 knots. In 1897 it had grown to 150 ft. in length, 140 to 150 tons, 2,000 horse power, and 26 knots. Destroyers are not yet of seven years' standing, but they come under the rule. The first examples —1893—were 180 ft. long, 240 tons, 4,000 horse power, and 26 to 27 knots. They were followed by 30-knot vessels, 200 ft. to 210 ft. long, 280 to 300 tons, 5,500 to 6,000 horse power. Vessels now in construction are to attain 32 to 33 knots, their lengths being about 230 ft., displacements 360 to 380 tons, and engine power 8,000 to 10,000 horse power.

Cost has gone up with size and power, and the limit of progress in this direction will probably be fixed by financial considerations rather than by constructive difficulties, great as these are as speeds rise. It may be interesting to summarize the distinctive features of torpedo vessel design:

(1) The propelling apparatus is excessively light in proportion to the maximum power developed. Water-tube boilers are now universally adopted, and on speed trials they are "forced" to a considerable extent. High steam pressures are used. The engines are run at a high rate of revolution—often at 400 revolutions per minute. Great care is taken in every detail to economize weight. Speed trials at maximum power only extend over three hours. On such trials in a destroyer each ton weight of propelling apparatus produces about 45 indicated horse power. Some idea of the relative lightness of the destroyer's machinery and boilers will be obtained when it is stated that in a large modern cruiser with water-tube boilers, high steam pressure and quick-running engines, the maximum power obtained on an eight hours' trial corresponds to about 12 indicated horse power per ton of engines, boilers, etc. That is to say, the proportion of power to weight of propelling apparatus is from three and a half to four times as great in the destroyer as it is in the cruiser.

(2) A very large percentage of the total weight—or displacement—of a torpedo vessel is assigned to propelling apparatus. In a destroyer of 30 knots trial speed, nearly one-half the total weight is devoted to machinery, boilers, etc. In the swiftest cruisers of large size, the corresponding allocation of weight is less than 20 per cent of the displacement, and in the largest and fastest mail steamers it is about 20 to 25 per cent.

(3) The torpedo vessel carries a relatively small load of fuel, equipment, etc. Taking a 30-knot destroyer, for example, the speed trials are made with a load not exceeding 12 to 14 per cent of the displacement. In a swift cruiser the corresponding load would be from 40 to 45 per cent, or proportionately more than three times as great. What this difference means may be illustrated by two statements. If the load were trebled, and the vessel correspondingly increased in draft and weight, the speed attained with the same maximum power would be about three knots less. If, on the other hand, the vessel were designed to attain 30 knots on trial with the heavier load, her displacement would probably be increased about 70 to 80 per cent.

(4) The hull and fittings of the torpedo vessel are exceedingly light in relation to the dimensions and engine power. For many parts of the structure steel of high tensile strength is used. Throughout the utmost care is taken to economize weight. In small vessels, for special service, many conditions can be accepted which would be inadmissible in larger sea-going vessels. The result of all this care is the production of hull-structures having ample general strength, but very little local strength; but notwithstanding all the accidents of navigation and collisions that have occurred in this class of vessel—and they have not been few—not one has yet foundered at sea.

These conditions are essential to the attainment of very high speeds for short periods. They resemble the conditions ruling the design of cross-channel steamers, so far as relative lightness of propelling apparatus, small load, and light scantlings are concerned. The essential differences lie in the requirements for passenger accommodation as compared with the requirements for armament of the torpedo vessel. No one has yet proposed to extend the torpedo vessel system to sea-going ships of large dimensions. Very similar conditions for the propelling apparatus have been accepted in a few cruisers of considerable dimensions, wherein high speeds for short periods were required. It is, however, unquestionable that in many ways, and particularly in regard to machinery design, the construction of torpedo vessels has greatly influenced that of larger ships.

One important consideration must not be overlooked. For short-distance steaming at high speeds economy in coal consumption is of little practical importance, and it is all-important to secure lightness of propelling apparatus in relation to power. For long-distance steaming, on the contrary, economy in coal consumption is of primary importance; and savings in weight of propelling apparatus, even of considerable amount, may be undesirable if they involve increased coal consumption. Differences of opinion prevail as to the real economy of fuel obtainable with boilers and engines such as are fitted to torpedo vessels. Claims are made for some vessels which represent remarkable economy. Only enlarged experience can settle these questions. Endurance is also an important quality in sea-going ships of large size; not merely in structures, but in propelling apparatus. The extreme lightness essential in torpedo vessels obviously does not favor endurance, if high powers are frequently or continuously required. Still, it cannot be denied that the results obtained in torpedo vessels show such a wide departure from those usual in sea-going ships as to suggest the possibility of some intermediate type of propelling apparatus applicable to large sea-going ships, and securing sufficient

durability and economy of fuel in association with further savings of weight.

THE PARSONS TURBO-MOTOR.

This rotary engine, introduced by Charles Algernon Parsons, with its very high rate of revolution, reduces the weights of machinery, shafting and propellers greatly below the weight required in the quickest running engines of the reciprocating type. This reduction in the proportion of weight to power carries with it, of course, the possibility of higher speed in a vessel of given dimensions, and when large powers are employed the absolute gain is very great. An illustration of this has been given by Mr. Parsons in the *Turbinia*. That remarkable vessel is 100 ft. long and of 44 1-2 tons displacement, but she has attained 33 to 34 knots in short runs. There are three shafts, each carrying three screw propellers, each shaft driven by a steam turbine making over 2,000 revolutions at full speed, when an aggregate of more than 2,000 horse power is developed. A water-tube boiler of special design supplies steam of 175 lb. pressure, and is exceptionally light for the steam produced, being highly forced. The whole weight of machinery and boiler is 22 tons; in other words, about 100 horse power indicated is produced for each ton weight of propelling apparatus. This is rather more than twice the proportion of power to weight as compared with the lightest machinery and boilers fitted in torpedo boats and destroyers. It will be noted that in the *Turbinia*, as in the destroyers, about half the total weight is devoted to propelling apparatus, and in both instances the load carried is relatively small.

The secret of the extraordinary speed is to be found in the extreme lightness of propelling apparatus and small load. No doubt in the *Turbinia* lightness has been pushed further than it would be in vessels of larger size and greater power. In such vessels a lower rate of revolution would probably be accepted, additional motors would be fitted for manœuvring and going astern, boilers of relatively greater weight would be adopted, and other changes made. But after making ample allowance for all such increases in weight, it is unquestionable that considerable economies must be possible with rotary engines. Two other vessels of the destroyer type with turbo-motors—one for the royal navy—are now approaching completion. Their trials will be of great interest, as they will furnish a direct comparison with vessels of similar size and form, fitted with similar boilers and driven by reciprocating engines.

On the side of coal consumption Mr. Parsons claims at least equality with the best triple-expansion engines. Into the other advantages attending the use of rotary engines it is not necessary now to enter. Reference must be made, however, to one matter in which Mr. Parsons has done valuable and original work. In torpedo vessels of high speed the choice of the most efficient propellers has always been a matter of difficulty, and the solution of the problem has in many instances involved extensive experimental trials. By means of alteration in propellers alone very large increases in speed have been effected; and, even now, there are difficulties to be faced. When Mr. Parsons adopted the extraordinary speed of revolution just named for the *Turbinia*, he went far beyond all experience and precedent, and had to face unknown conditions. He has found the solution, after much patient and original investigation, in the use of multiple screws of small diameter. His results in this direction are of general interest to all who have to deal with screw propulsion. Such radical changes in propelling machinery as are involved in the adoption of turbo-motors must necessarily be subjected to thorough test before they will be widely adopted.

The experiment which the Admiralty are making is not on a small scale as regards power. Although it is made in a destroyer, about 10,000 horse power will probably be developed, and a correspondingly high speed attained. It may well happen that from this experiment very far-reaching effects may follow. Mr. Parsons himself has prepared many designs illustrating various applications of the system to sea-going cross-channel and special service vessels. Where shallowness of draft is unavoidable, the small diameter of the screws possible with the quick-running turbines is clearly an important matter.

COMPARISONS BETWEEN LARGE AND SMALL VESSELS.

It has been shown that the attainment of very high speeds by vessels of small size involves many conditions not applicable to large sea-going steamships. But it is equally true that in many ways the trials of small swift vessels constitute model experiments, from which interesting information may be obtained as to what would be involved in driving ships of large size at speeds much exceeding any of which we have experience. When the progressive steam trials of such small vessels can be studied, side by side with experiments made on models to determine their resistance at various speeds, then the fullest information is obtained, and the best guide to progress secured. This advantage, as has been said, we owe to William Froude. His contributions to the "Reports" of the British Association are classics in the literature of the resistance and propulsion of ships. In 1874 he practically exhausted the subject of frictional resistance so far as it is known, and his presidential address to this section in 1875 dealt fully and lucidly with the modern or stream-line theory of resistance. No doubt there would be advantage in extending Froude's experiments on frictional resistance to greater lengths and to ship-shaped forms. It is probable also that dynamomentric determinations of the resistance experienced by ships of modern forms and considerable size when towed at various speeds would be of value if they could be conducted. These extensions of what Froude accomplished are not easily carried out, and in this country the pressure of work on shipbuilding for the royal navy has for many years past taxed to the utmost limits the capacity of the Admiralty experimental establishment, so ably superintended by R. E. Froude, allowing little scope for purely scientific investigations, and making it difficult to deal with the numerous experiments incidental to the designs of actual ships.

Now that Holland, Russia, Italy and the United States have equipped experimental establishments, while Germany and France are taking steps in that direction, we may hope for extensions of purely scientific work and additions to our knowledge. In this direction, however, I am bound to say that much might be done if experimental establishments capable of dealing with questions

of a general nature relating to resistance and propulsion were added to the equipment of some of our universities and colleges. Engineering laboratories have been multiplied, but there is as yet no example of an experimental tank devoted to instruction and research.

It is impossible, and possibly is unnecessary, to attempt in this address any account of Froude's "scale of comparison" between ships and models at "corresponding speeds." But it may be of interest to give a few illustrations of the working of this method, in the form of a contrast between a destroyer of 300 tons, 212 ft. long, capable of steaming 30 knots an hour, and a vessel of similar form enlarged to 765 ft. in length, and 14,100 tons. The ratio of dimensions is here about 3.61 : 1, the ratio of displacements is 47 : 1, and the ratio of corresponding speeds is 1.9 : 1. To 12 knots in the small vessel would correspond 22.8 knots in the large vessel, and the resistance experienced by the large vessel at 22.8 knots—neglecting a correction for friction—should be forty-seven times that of the small vessel at 12 knots. By experiment this resistance for the small vessel was found to be 1.8 ton. Hence, for the large vessel at 22.8 knots, the resistance should be 84.6 tons. This would correspond to an "effective horse power" of over 13,000, or to about 26,000 indicated horse power. The frictional correction would reduce this to about 25,000 horse power, or about 1.8 horse power per ton.

Now, turning to the destroyer, it is found experimentally that at 22.8 knots she experiences a resistance of about eleven tons, corresponding to an effective horse power of over 1,700 horse power and an indicated horse power of about 3,000 horse power; say, 10 horse power per ton, or nearly five and a half times the power per ton required in the larger vessel. This illustrates the economy arising from increased dimensions.

Applying the same process to a speed of 30 knots in the large ship, the corresponding speed in the small ship is 15.8 knots. Her resistance at that speed is experimentally determined to be 3.5 tons, and the resistance of the large ship at 30 knots, neglecting frictional correction, is about 165 tons. The effective horse power of the large ship at 30 knots is, therefore, about 34,000 horse power, corresponding to 68,000 horse power indicated. Allowing for the frictional correction, this would drop to about 62,000 horse power, or 4.4 horse power per ton.

For the destroyer at 30 knots the resistance is about 17 1-2 tons, the effective horse power is 3,600 horse power, and the indicated horse power about 6,000 horse power, or 20 horse power per ton—nearly five times as great as the corresponding power for the large ship. But while the destroyer under her trial conditions actually reaches 30 knots, it is certain that in the large ship neither weight nor space could be found for machinery and boilers of the power required for 30 knots, and of the types usually adopted in large cruisers, in association with an adequate supply of fuel. The explanation of the methods by which the high speed is reached in the destroyer has already been given. Her propelling apparatus is about one-fourth as heavy in relation to its maximum power, and her load is only about one-third as great in relation to the displacement, when compared with the corresponding feautres in the cruiser.

ADDITIONS TO THE TRANSATLANTIC FLEET OF THE FRENCH LINE.

Additions to the fleet of the French line maintaining the mail service between Havre and New York, are to be made in accordance with the governmental (French) convention of 1898. Two new vessels are to be added to the fleet, the *La Lorraine* recently launched at the yards of the Compagnie Générale Transatlantique at Pewhoët-Saint-Nazaire, and a sister ship, the *La Savoi* is to be launched next spring.

Lately the French line put in service the former Hamburg-American liner, *Normannia,* under the new name of *L'Aquitaine.* This vessel was purchased from her German owners by the Spanish Government during the war in Cuba, and was renamed the *Patriota,* the intention being to fit her out as an auxiliary cruiser. It is, we believe, the fact that the work of refitting the vessel was never carried out. At any rate she did not figure in the public eye during the war, and now has gone back to the purposes of peace. Her dimensions are: Length, 520 ft.; beam, 57 ft. 6 in.; depth, molded, 38 ft.; displacement at 24 ft. draft, 11,500 tons. She has twin screws, triple expansion engines of 16,300 I. H. P. and a sea speed of about 18 knots. She was built at the Fairfield yard on the Clyde, and broke the builder's record, in that she was built complete and sent on her trial trip within the space of twelve months. She came out in 1890, and is therefore a comparatively new boat.

The new boats of the company will be considerably larger, and through the courtesy of the New York managers of the French line we are able to give particulars of the one recently launched, the *La Lorraine.* Her principal characteristics are as follows:

Length over all	580 ft.
Beam	60 ft.
Depth	39 ft. 6 in.
Displacement at mean draft of 25 ft. 3 in	15,200 tons.

Her construction was under the supervision of the Bureau Veritas, is of mild steel throughout, with the special use of a steel of higher grade in certain parts to insure longitudinal rigidity.

There are five decks extending the entire length of the ship with a sixth deck about 330 ft. in length serving to shelter the promenaders of the first and second-class passengers. Above the latter deck are placed the life boats to the number of eighteen, together with the life rafts. Two bridges, one above the other, surmount this sixth deck forward of the two funnels, the upper bridge being about 50 ft. above the mean load water line. Safety against foundering is assured by sixteen transverse water-tight bulkheads, and one longitudinal bulkhead separating the two main engine rooms. A cellular water bottom with a capacity of 1,100 tons provides for the variations needed to insure the stability of the ship under the varied conditions of use.

The motive power comprises two four-cylinder vertical triple expansion engines, with Stephenson valve gear. The cranks are provided with counterbalances to reduce the vibration effects. All the auxiliary machinery is fitted independent of the main engines. The boilers are sixteen in number, single ended, 17 ft. dia. and 10 ft. 9 in. long. Each boiler has four 44 in. furnaces, making a total of 64 fires divided be-

tween four transverse fire rooms. The service pressure is 163 lbs. per square inch. The bunker capacity is 3,000 tons.

The total length of the compartments for boilers, coal bunkers and machinery is about 58 per cent. of the length of the ship.

The accommodations for the first and second-class passengers are in the first between-decks and in the two domes described below. The first between-decks contains, starting from aft, the second-class staterooms for a length of 120 ft. the remainder of the deck to within about 80 ft. from forward being occupied by first-class staterooms, boudoirs for ladies, hair-dressing parlor, bath-rooms, etc. The children's dining room with forty places is also on this deck, and sensibly in the middle of the ship. The grand cylindrical dome, whose length is about 330 ft., contains in the central region of the ship the dining-room or main saloon for first-class passengers. The dimensions of this room are 59 ft. in length by 46 ft. in width. The principal part of the room is occupied by three tables of 42.6 ft. length, with 122 chairs of the usual swiveling type. Sofas are fitted at the sides and small transverse tables to the number of fourteen, each with five places. At the two ends forward and aft are placed sideboards for silver ware, desserts, etc. This room which provides seats for 192 persons at one time is lighted and ventilated by rectangular windows in the walls of the dome, and by a large glazed skylight. A special arrangement comprising air ducts and electric ventilators, is furthermore provided for use in case the windows cannot be opened. Forward of the saloon are found the grand stairway, and special staterooms, while aft the various offices, kitchens, bakery, etc., are located.

The grand upper dome, of equal length with the lower, is placed immediately over it, and contains directly over the grand saloon, the social hall and the reading room, 65.6 ft. in length by 36 ft. in width. The entrance-way for first-class passengers is directly over the entrance to the lower dome. The first-class smoking room is placed at the forward end of this dome and is 46 ft. long by 34.5 ft. wide. It contains seats for 84 persons. Between the smoking room and the grand stairway are placed a number of special staterooms, a private parlor, café, bathrooms, w. c., etc.

The second-class saloon, ladies' room and smoking room are placed in the two superposed domes on the forward part of the poop.

The third-class passengers are lodged in the second between-decks, separate apartments being provided for families and for single women.

The vessel has passenger accommodation as follows: Special and extra special, 59; saloon, 378; intermediate, 118; steerage, 398. The personnel is made up of: Officers, 22; sailors, firemen, etc., 192; stewards, servants, etc., 158.

On 6 hours' trial the *La Lorraine* is expected to make 22 knots speed with 22,000 I.H.P. Armament, when fitted out as an auxiliary cruiser, includes nine 5.5-in. rapid firers and eight machine guns of large caliber.

The estimated cost is $2,316,000.

The company will shortly put on two large freight steamships for the New York route. These are recently built British vessels and will be known as the *Bordeaux* and *Pauillac*.

SHIPBUILDING PLANT OF THE UNION IRON WORKS AT SAN FRANCISCO.*

The Union Iron Works, where the famous battleship *Oregon* was built, is the largest engineering establishment on the Pacific Coast, and one of the largest and best equipped marine engineering plants in America. The works have been in existence, under different names, since 1849. Originally their chief product was stationary work, mining machinery being a specialty, and many of the great pumps and hoisting engines of the famous Comstock lode were built at these works. The present shops were built in 1883, and the first steamship, a coasting vessel called the *Arago*, was completed in 1884. She was also the first iron ship built on the Pacific Coast.

The works are located at San Francisco, and cover an area of 28 acres, with a frontage of 1,900 ft. on San Francisco Bay. They are completely prepared to build and fit out steel steamships of any size, and the magnificient equipment of the various shops must be seen to be appreciated. The main buildings, such as foundry, machine, boiler, blacksmith and erecting shops, are fireproof, having iron frames and brick walls with few upper floors or galleries, the most of the work being done on the ground floor. The shops are connected with each other, and to the shipyard by a system of tracks on which steam traveling cranes afford easy and rapid transfer of work from the shop cranes to the 100-ton shears on the dock. Facilities for handling work is a point on which particular care has been exercised.

The iron foundry is a building 90 ft. by 100 ft. It has three cupolas, the largest of which is of 50 tons capacity. Castings of 60 tons weight have been made, and work of twice that size could be poured if necessary. The shop is provided with two overhead cranes, one a pneumatic crane of 50 tons capacity, and one 15 ton electric crane. The walls are also lined with hydraulic jib cranes for lighter work. At present 140 men are employed in this department. There is also a brass foundry employing 60 men, in which six tons can be poured at one time. This is a very busy shop, as the firm makes a great deal of brass work, such as valves and marine fittings, that most shops buy from special manufacturers. It is fitted with an overhead electric crane of 12 tons capacity.

The machine shop is 200 ft. square, covered with a roof of iron and glass, and very well lighted from the sides as well. It is divided by the columns that support the roof into five aisles. The largest of the machine tools are arranged along the sides of one of these aisles. Two of them, the great vertical boring mill, and the combination planing and slotting machine, are of home manufacture and are worthy of special notice. The former can bore and turn, simultaneously, a wheel 30 ft. dia. with 10 ft. face. The boring device is entirely independent of the turning mechanism, and, boring can be done equally as well, whether the table rotates or not. Several tools can be run at once, when turning wide faces, and the work is very accurate for such a large tool. The combination planing machine was designed for facing off large surfaces, such as engine beds.

*From our own special correspondent.

It can finish a surface 20 ft. by 30 ft. at one setting, the tool cutting on both strokes, either up and down, or forward and backward horizontally. Besides these, there is in this aisle a planing machine of the ordinary type, that can surface a piece 10 ft. square and 22 ft. long; a Bement Miles lathe that can swing 125 in. 40 ft. between centers; another lathe of 120 in. swing 50 ft. between centers; a radial drill of 10 ft. radius; and a large slotting machine. Two 40-ton overhead electric cranes, running on the same track, handle the work in this aisle. Tools considerably smaller, but large enough to be classed as very large ones in most shops, are arranged in another aisle over which run two 20-ton electric cranes; while yet another aisle is occupied by tools still smaller, which are served by two 5-ton overhead electric cranes operated from the floor, and running on the same track. The small tools fill the remaining aisles, and also a gallery built over one of them. In this gallery a great many brass finishing tools are placed to finish the product of the brass foundry already mentioned. The arrangement of the tools throughout the shop is very fine, and the facilities for handling work excellent. The overhead cranes are supplemented by hydraulic jib cranes for light work, and car tracks run both ways of the shop. There are a great many special tools, not often seen in similar shops, and many portable tools are operated by either air, hydraulic or electricity. About 300 men are employed in the machine shop.

A portion of the shop has been set apart for an electrical department, which, under the able supervision of the Chief Electrician, W. W. Hanscom, has, from a small beginning, grown to be a department of great importance. It is well supplied with the necessary tools and employs, in the shops and outside, about 130 men. The department has its own corps of draftsmen, and complete electric lighting installments, and all such naval auxiliaries as ammunition hoists, etc., are here designed and built.

The erecting shop is separate from the machine shop, and is fitted up especially for the purpose. The erecting is all done on the ground floor, which is 90 ft. by 200 ft., and is divided into two parts, lengthwise, one for heavy and one for light work. Over the former runs two 50-ton electric cranes, while over the latter are two 5-ton cranes of the same type. A large portion of the floor is made of surfaced cast iron sole plates, which rest on solid foundations, and are provided with T slots for bolting down the work under erection. Pits are provided for work having large flywheels, and a portion of the floor is set apart for testing purposes. Here the proper connections are provided for testing all kinds of work, with either pneumatic, hydraulic or steam pressure, and here also all the small engines are tested by actual running. A great number of these engines are turned out, as this concern, unlike many others, builds all its own auxiliary engines for forced draft, ventilation and the like.

The pattern shop is a four-story brick building, the three upper stories of which are literally filled with patterns. About 40 men are employed.

The blacksmith shop has 24 fires and employs 60 men. It has a good equipment of hydraulic jib cranes for handling heavy work under the hammers.

WATER FRONT VIEW OF THE SHIPYARD OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.—FRAME WORK OVER BUILDING SLIPS AT RIGHT OF PHOTOGRAPH.

The boiler shop is a new building, 90 ft. by 200 ft., with a flanging shop 60 ft. by 100 ft. attached. The frame is of steel, the walls of brick, and the interior is particularly well arranged and equipped. It contains some large tools, among which might be mentioned the large hydraulic riveter, with 12 ft. gap; the vertical bending rolls, that can roll 1 3-4 in. plate 10 ft. wide; the horizontal rolls, that can bend 1 1-4 in. plate 18 ft. wide; and the guillotine shears, that can shear 88 in. of 1 in. plate at one cut. There is also a new boiler shell drilling machine, in which a 16 ft. boiler can be set up on end and five drilling heads, each head operating three drills, can be worked simultaneously upon it. Flanging is done with a large Tweddell hydraulic flanging machine, circular flanges are beveled on a large milling machine made for the purpose, and manholes in heavy plate are cut with an elliptical boring machine or manhole cutter. There is a fine assortment of punches, shears, gang drills, etc., and plenty of hydraulic jib cranes for handling the light work. Two 50 ton, overhead electric cranes, traveling on the same track, do the handling in the main shop, and the two large riveters have overhead traveling cranes of their own. All the large shears, punches, rolls, etc., are driven by independent motors. At present, twelve Thornycroft boilers are in course of construction, in a temporary shop, adjoining the boiler shop, which has been fitted up for that purpose, and several very ingenious special tools may be seen at work here.

In the shipyard are seven slips of different sizes. Four of them have wooden frameworks erected over them, as seen in the accompanying illustration, the largest being 80 ft. by 470 ft. in the clear. Two electric cranes run side by side along the entire length of these frameworks, above the ship, under construction. Each crane covers half the ship, and plates or beams can be handled with ease on any part of the vessel. The furnaces and bending floors have cranes for handling the heavy work, and ribs for the largest ships can be bent without difficulty. The shipsmith shop alone employs 70 men, and has its own outfit of three steam hammers, bolt and rivet making machinery, and furnaces for the same. There is also a 300 ton hydraulic forging press, of home manufacture, with furnaces and overhead crane to suit. Besides the many necessary punches, shears, etc., there are six plate planing machines, from 16 to 24 ft. stroke, large bending rolls, that can bend 1 1-2 in. plate 22 ft. 6 in. wide, and two hydraulic bending machines for bending plates cold. One of these benders, also of home production, is a monster machine, which can take in plates 22 ft. 6 in. long between the uprights, and exerts a pressure of 600 tons. The bedplate weighs 60 tons, and the upper or bending beam weighs 40 tons. Many portable tools are in operation, driven either by air, hydraulic or electricity, and the equipment throughout is very complete and well arranged.

Near the yard is the hydraulic lift dock,[1] and also the 100 ton shears, already referred to. This last is operated by electricity, and is a very convenient appliance.

There is also in connection with the yard a galvanizing plant, boat shops, joiner shop, copper shop and sail loft, in fact, every department necessary for fitting out ships in detail.

[1] See Vol. IV, page 189.

The motive power of the works is obtained from a central power station, in which are installed two 400 H.P. vertical triple expansion engines, and two 100 H.P. engines of the same type, all direct connected to dynamos. Nearly everything, including the electric lighting system, is driven from this central station. The large tools throughout the works are driven by independent motors, and nearly all the line shafting, driving groups of machines, is driven in a similar manner. The engines, dynamos, and nearly all of the 225 motors, used in distributing power throughout the works, are of home design and manufacture, and are first-class in every respect.

The plant has its own pneumatic and hydraulic systems, both of which are very comprehensive, and operate hundreds of stationary and portable tools.

The latest addition to the works is a converter plant for making steel castings. The cupola, and a 2-ton Tropenas converter, is already erected, and will soon be ready for operation.

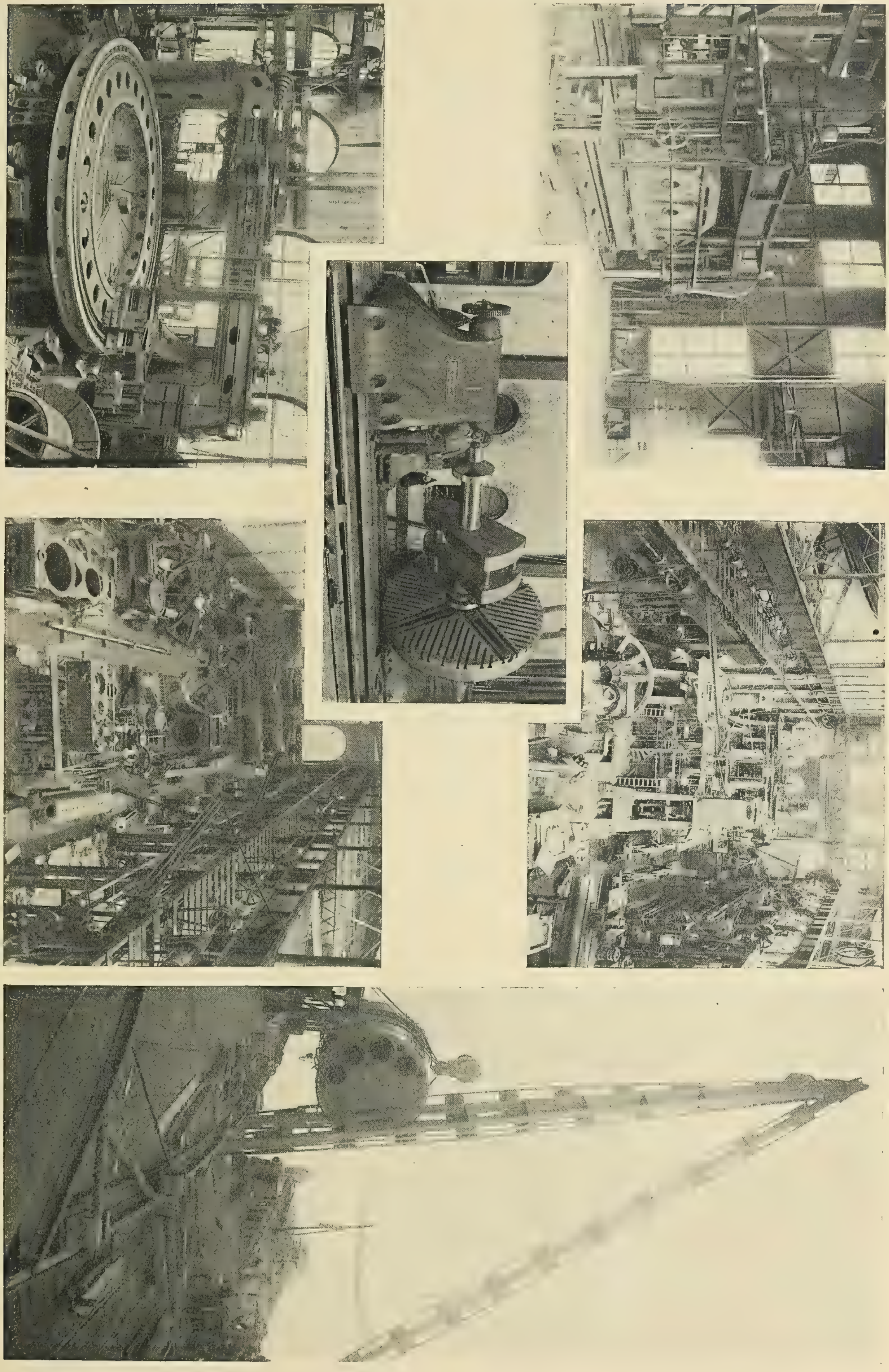
The office building is a new four-story brick structure, 40 ft. by 190 ft. The entire third floor is one room, and is used as a drafting room, in which 60 men are at work. About 3,000 men are now employed by the firm, including the force at the branch works, where the most of their mining work is now done.

Many merchant ships, tugs, and small craft have been built at this yard, and a number of vessels for the United States Government, including the cruisers *Charleston*, *San Francisco* and *Olympia*; the gunboats *Marietta* and *Wheeling*, the monitor *Monterey*, the torpedo boat destroyer *Farragut*, and the battleship *Oregon*. They have also recently finished and turned over to the Japanese Government the fast cruiser *Chitose*, the first contract for a warship made with a foreign power.

At present they are building the battleships *Wisconsin* and *Ohio*, the monitor *Wyoming*, and the torpedo boat destroyers *Preble*, *Perry*, and *Paul Jones*, all for the United States Government. Work is progressing on a large steel paddle wheel ferryboat for the Atchison, Topeka and Santa Fe R.R., for service on San Francisco Bay, and also on the large freight and passenger steamer *Californian* for the American-Hawaiian Steamship Company, which was described in our August issue. (1899.)

The officers of the company are: President, H. T. Scott; Vice-President, I. M. Scott; Secretary, J. O. B. Gunn; Manager, G. W. Dickie. To the Superintendent, John Scott, and the Assistant Manager, I. M. Scott, Jr., we are indebted for much information and the accompanying photographs.

U. S. S. CONSTITUTION.—The *Constitution*, more familiarly known as "*Old Ironsides*," is at the Boston Navy Yard, housed over and used as a training ship. She was built in Boston more than 100 years ago, and took part in many memorable engagements, including the attack on Tripoli under Admiral Decatur, where she was his flag ship; and under Captain Isaac Hull she gained the famous victory over the *Guerriere* in 1812. Her dimensions are: Length between perpendiculars, 175 ft.; beam, 45 ft.; mean draft, 20 ft.; displacement, 2,200 tons. The movement which has for its object the refitting of the old *Constitution* deserves widespread support.



PHOTOGRAPHIC VIEWS OF THE INTERIORS OF SHOPS, SPECIAL TOOLS AND 100 TON SHEARS, AT SHIPYARD OF UNION IRON WORKS, SAN FRANCISCO, CAL.

SUGGESTIONS AS TO IMPROVED APPLIANCES FOR LAUNCHING SHIPS' BOATS.*

BY JOHN HYSLOP.

It is a characteristic of the present time, which forces itself upon the attention and into the recognition of the least observed, that there is a restless and ceaseless activity to meet in every variety of form and method all the numberless wants and demands that society feels, and to which any expression is given; and the exercise of industry, ingenuity, and invention to this end has become so common and has been so successful that the most marvelous productions are simply in line with expectancy, and scarcely any longer excite wonder or admiration. While this state of matters obtains in regard to things generally, and while the devices and methods of fifty years ago have been, like the flint-lock gun and the stage coach, put away to make room for more modern and superior contrivances, it yet remains that the vast development of ocean travel in the past half century and the increased water traffic of every kind has been unattended, excepting in rare instances, with any change whatever in the method of launching ships' boats, and with only here and there such changes in detail as leave the vital requisites yet to be found, recognized and put into use. Such a state of things is in these times an anomaly, and confronts us with the question: Why should this be so? This is much more easily asked than correctly and satisfactorily answered, and in a measure the solution of it must be left to the unaided consideration and conviction of each individual. It is, however, impossible to believe that the difficulty lies wholly in the lack, with proper inducements, of ability in contrivance.

It is equally clear that any progress in this matter, any effort to introduce improvements, to be successful must be well-devised and practically adapted to conditions, and must be aided by an aroused public feeling. One cause, doubtless, why more has not been done in the attempt to improve has been in the lack of technical knowledge on the part of those with whom has rested the adoption of new propositions, and a consequent want of confidence in any estimate they might make of the value of such propositions, or of the possibility of effecting any amendment. Another cause has probably been that, in the very nature of the case, marine disasters are removed from public observation, and impressions in regard to them usually come from survivors; and these in the worst cases are few, or perhaps none. Abundant proof has been had from time to time of the power of a ship's boat, successfully launched and well handled, to survive the storm in which the vessel herself foundered; yet how many are the cases which will come to memory of any who may choose to recall them of vessels that have left port never to be again heard of. The writer has no wish to be an alarmist, but in this matter to be forewarned should assure that we be forearmed. We all know the suddenness with which disasters may occur to any vessel, some of them of a character such as no human care or foresight can foresee and no human skill can prevent, and to meet these no means of launching boats other than the most prompt and reliable can be of any avail whatever. It is not alone that a ship may strike off a rocky coast on a dark night and be under water in ten or fifteen minutes through faulty and unchecked navigation; such occurrences can be rendered far from likely by better methods and checks which, I am happy to know, have been introduced on some of the best steamship lines; but who shall say that any means yet devised will prevent the possibility of collision with an iceberg or a derelict on a dark night or in a fog?

In case of such an event it is not to indulge in mere hypothesis or speculation to say that, with a vessel proceeding at any ordinary speed nothing but the most speedy launching of boats would be effectual to save a single life. To say this is not to speculate, but to state the result which might reasonably be expected. In this respect to have had boats afloat in five minutes would, no doubt, in disasters of the past have been the means of saving countless hundreds of human lives, where an inability to do this in fifteen minutes, or even ten, has meant blank failure and a calamitous end to faithful and heroic efforts, which in many cases may have left no record and only blank mystery. If any apology is needed for presenting a subject in this way to a society which, perhaps, in mere ordinary course is accustomed to give its attention exclusively to matters of economy and mechanics, it may be accepted as sufficient that the writer regards the Society as more capable than any other of dealing instructively and effectively with the question; and he hopes, by impressing upon the Society the need of improvements, to enlist its aid to the effecting of them. He has greater expectation from this, and from remarks and suggestions which may be made as the result of reading this paper, than he has from any original devices or suggestions that he may be able to present. As a further excuse for dwelling somewhat on the need of improvements, and of greater attention to the subject of launching ships' boats, the writer feels impelled to state that he has stood four different times on ships' decks when it has been necessary to launch boats to save life, and on none of them was this quickly and effectively carried out. On the last and most disastrous of these occasions it was most distressing to see 150 men, women, and children waiting through ten to fifteen minutes, each elapsed minute narrowing the limit of life to over two-thirds of that number, only one boat being got clear of the ship, and that one in a damaged condition, through efforts faithful, persistent, strenuous, efforts attended in some instances with serious injury to workers, which ceased only when workers and passengers were submerged.

The question has no doubt occurred ere this to the mind of many of those I am addressing: "Wherein is the difficulty?" And some of these may say: "I have seen boats put afloat from a ship's deck within three minutes from the time when the order was given." This is quite true where all conditions are favorable—where it is daylight and everything is in plain view, where the ship is neither rolling nor listed to starboard or port, where, perhaps, only one boat has to be launched, and this one handled exclusively by sailors; but the impression gained by any such experience is apt to be misleading, and it has, I feel assured, misled many who have an interest in such matters.

A better conception of this state of things may be had if I should refer to an examination of the appliances

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers held in New York.

for launching on one of the largest transatlantic steamships recently made, in the company of one of the ship's officers. The davits were of the ordinary kind, turning in sockets on the ship's sides, and with the heads usually turned inboard and over the boats, resting in chocks upon the vessel's upper deck many of the details connected with launching were excellent, and I shall have hereafter to refer to and recommend some of them.

The boats were large and heavy, but it was easy to credit the claim made that on occasions one of these had been put into the water in two and a half minutes. When, however, the question was asked, "What could you do if the vessel was rolling or listed?" the answer was, "We know we could not launch them at all." This answer has since been confirmed by other practical and intelligent officers to whom it has been put. The chief difficulty appears to be this, that while it is comparatively easy to turn heavy davits and to move boats in the direction of a horizontal plane, and while such davits and boats will stay out, and the davits can be stayed by the ordinary guys in the inboard or outboard position when the ship is upright in quiet water, neither movement is practicable when the vessel is rolling or pitching in a seaway, or when she is listed to port or starboard. On the contrary, as I know from experience and actual occurrence, attempts to get the boats over the side at such times are liable to be attended with the loss of life or limb, or by other injury; and the most strenuous efforts made and long continued are apt to be wholly abortive. The crudity and inadequacy of these contrivances would seem to be obvious to any one whose attention is called to them, and indeed the certainty of difficulty, if not defeat, under any but the most favorable conditions.

Where it is expected that heavy boats will have to be used with any frequency at sea it is, I think, safe to say that no such means of launching them would be relied on. It would be regarded as a novelty to see a whale ship fitted with davits of this kind. While it is not to be expected that Atlantic liners shall be fitted with whale ship's davits, it appears both interesting and instructive to inquire how far it is practicable to carry ship's boats inside the lines of a ship's side and yet at all times outside the davits; and also to inquire if any better means can be used to operate and control the present common form of davit. Before doing this it may be well to mention the chief details of work necessary in launching: Removal of the canvas covering, casting off the gripes, throwing down the outer chock (if this be so arranged), casting off the lanyards or tackles of the guys, hoisting the boat clear of its seat, pushing outward the boat and davits and securing the guys, lowering away evenly the boat by the falls, and unhooking the falls and pushing clear of the ship. Every one of these processes is important, and many of them in instances have been improved. In the search for new forms of davits it is questionable if the same identical form will be found equally applicable in all cases; and even if the same form is found to be generally applicable, some modification of detail will be necessary. To my mind the principle of the Mallory davit, patented 1871 and 1873, has much to recommend it; it is simple, and vastly superior to the common form.

It is inexpensive, but not bulky; has no need of guys. The boat, though kept inboard, is always outside the davits, and gravity alone will carry the boat outward ready for lowering when the ship is on an even keel or only moderately listed; and when more extremely listed, any force used to overcome this is more easily and much more effectively applied. The accompanying illustrations, Figs. 1 and 2, will make the construction and the mode of operation sufficiently clear. A frame made of stout angle-iron is extended outward from the top of a house or boat deck, across the width of the gangway of the deck below, and then vertically to that deck, where it terminates and is secured inside the rail; the horizontal part and a small portion of the vertical part of this frame is made double, with a separation and a space of approximately 2 in. between the two members of the frame. Hinged near to the house on the lower deck, on a level with the foot of the frame and separated from it by the width of the gangway, is the davit; this extends upward from the hinge to and beyond the inboard side of the boat, over which the head is bent in the usual manner.

When the boat has to be launched it is raised by the falls from its seat, the chocks thrown down and the boat allowed to move outward by means of the fall attached to the back of each davit, and to a distance sufficient for the boat, when lowered in the ordinary or in any other way, to be clear of the ship. This form of davit does

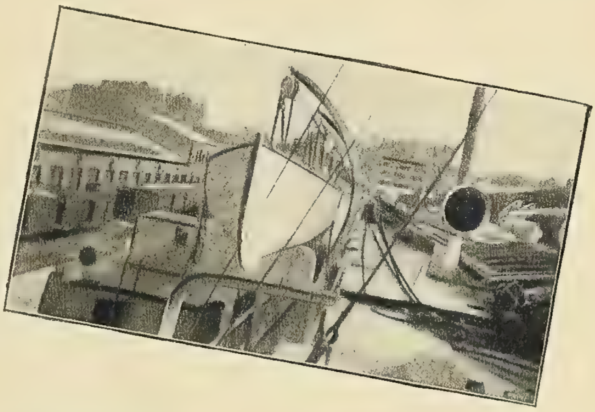


FIG. 1. VIEWS OF MALLORY DAVIT. FIG. 2.

not appear to have been adopted or known to the extent that might have been expected. It is a strong and a light device, the strain upon it being only in one direction, and there being no occasion to make it circular in cross-section, being made from flat bar iron. Those I have seen on the newer vessels of the Old Dominion Line (used for boats not of the heaviest kind) being about 5 in. by 1 1-4 in. in cross-section. There is no

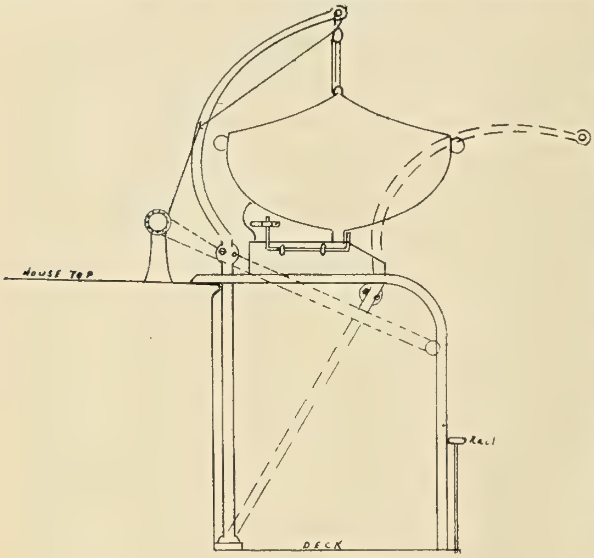


FIG. 3.

uncertainty, in my view, as to the advantages of this davit, and none as to the differences in result which might have been attained to had this method of working been in use where it was my painful experience to see others fail.

It is, however, I think, susceptible of adaptations that have not yet been made, and is too open to the criticism that the means to operate it under favorable and also unfavorable conditions are not present, are not all of them fixtures, and always ready for use. The fact that two tackles, one to each davit, have to be stretched across the deck, then seen to be clear, and hooked on before the davits are operated, is an objection; and although, in case of rolling or of extreme list, these davits would be much easier to control than the ordinary ones, this is not enough. To fitly meet such occasions as arise, appliances should be such as by reliable and simple means, not to be defeated by rolling or listing, requiring only manual power, and few men, and controllable throughout the process, the boat must be moved out to a position ready for lowering. The operative means to effect this should be a reasonably compact and unobtrusive fixture, always ready for use. Reference to Figs. 1 and 2 will show how easily could be arranged in connection with them a small shaft upon the upper deck, running in line with the boat and just inside the davits; this shaft could be supported at each end by a compact frame or standard, have winch handles on, and a sprocket wheel near to each end; over this wheel would pass a chain which would also pass over a pulley upon the outer part of the davit frame. The ends of the chain would be connected with the davit on opposite sides in such a way that the revolution of the sprocket wheel by handles would move the davits either outward or inward, or hold them at any point desired.—Fig. 3.

It will be seen how a turn with the bight of the boat falls, over a small drum placed on the shaft, would at the same time carry out the davits and raise the boat from its seat. In such ships as have a shelter deck extending over the width of the gangway of the deck below, davits of the form shown could not be used without the shelter deck, on which the boats rest, having slots cut in them for the movement of the davits outward and inward. The extent of such slots could, doubtless, be much reduced in such cases by modifying the form and curvature of the davits, and, if need be, by also changing somewhat the detail of the method used for operating them, and this without any departure from the general character of the means used. It does not appear evident, however, that any insuperable difficulty or objection can apply, on account of weakening or impairment of the shelter deck through the presence of such slots, which could be supplied with proper curbs, and which openings the chock would ordinarily cover. The writer will not pretend to deal exhaustively with this, or, indeed, with any other part of this subject, with the mechanical parts of which he feels that many of the capable minds of this Society can deal more effectively than he can.

Any reference to the class of davits which fall outward from the sides of a vessel would be very incomplete which should omit the ingenious and well-worked-out device of Sir Bradford Leslie, of Falmouth, England.

FIG. 4.

Sir Bradford is a retired engineer of much experience in the East Indies.

His life was placed in jeopardy by shipwreck some years ago, and he has shown that he possesses the requisite technical skill to deal with the detail of his invention in a very thorough manner. For an intimate acquaintance with it I must refer you to the U. S. pat-

ent, May 4, 1897, number 582,069. (See Fig. 4, reproduced from the patent.) The chief novelties of his method are that there are no boat falls, no lowering or hoisting tackles attached to the boats—these are supported from below on cradles situated on the heads of the davits. The davits themselves are lowered vertically in slides down the outside of the ship through a space of a few feet; having passed downward through this space the heads of both davits, with the boats resting upon them, fall evenly outward and downward until the boat is deposited on the water at an oar's length or more away from the ship, the davits being allowed to sink a sufficient distance free of the boat. This lowering apparatus consists of a wire rope wound round a drum on the ship's deck, and fitted with a suitable brake. A full description of this contrivance would fill the limits of this paper, and would occupy more time and space than is available.

In regard to the invention, I think it will be conceded that it possesses great originality and thoroughness—that it attains to many desirable ends. If it is thought to be too elaborate or too costly to meet with practical acceptance it will still, I trust, be deemed a sufficient reason for a reference to it in this paper that its methods are novel and calculated to afford a variety of useful suggestion. While the author of this ingenious invention may feel justly proud of it, my short acquaintance with him has given me a strong impression that he would feel nothing but gratification in having in any way promoted the successful achievement of the end he had in view.

It appears doubtful if any simple and reliable means can be devised for getting boats ready to lower where the davits have to be rotated, and where the boats have to be moved from a position inside the davits to one outside of them, and this operation, so easy when the deck is level and still, becomes one of extreme difficulty when the vessel is rolling, or when she is inclined; ordinarily the work involves time and effort which ought to be eliminated. The use of a cog-wheel sesured to the vertical part of the davit, say immediately over the rail of the vessel, the cogs of which wheel engage with a worm attached to a shaft running horizontally across the rail of the vessel, the shaft being turned by a handle situated on the periphery of a wheel placed on the inner end of the shaft, seems calculated to give a control over the whole range of the davit's movement not to be had in the ordinary way. The vessel on which I recently crossed the Atlantic had two of her boats fitted with davits operated in this way, and it seems strange that so simple a device is not in more common use.

The patent of James W. McKinnon, March 16, 1897, No. 579,119, has this appliance as one of its features, and has otherwise many ingenious contrivances for raising the boat clear of the chocks, and for the even and steady lowering of it, either from the deck of the vessel or from the boat itself; but I regret that I am not sufficiently familiar with the details of it to attempt a description, and copies of the patent papers do not, as I understand, show the latest form of the invention.

In discussing this subject I have hitherto occupied myself chiefly with the means for operating the davits themselves, and there is with me no doubt that here, more than anywhere else, is there a confessed need of improvement. I have spoken with many ships' officers, but have yet to meet with one who will say that, with the ordinary appliances, a ship's boat could readily be launched under conditions of practical difficulty such as have been alluded to. But, while the kind of davits and the mode of operating them is of first importance, every detail and process of launching ships' boats is important, and deserving of more attention than it appears to be receiving. Differences in equipment of vessels, often in regard to simple details which scarcely involve the matter of expense, and which do materially affect efficiency in working, suggest as explanation either a want of interest or a need of information, or even, more probably, the need of an institution or of a body of men who, duly qualified, could, more than any individual, be confidently relied upon to acquaint themselves with these somewhat technical matters, to digest the information received, and to make such statements or recommendations as should appear to be called for in the interests of humanity. With a large measure of authority would come from such a body a pronouncement in regard to any davit device observed; also in relation to the respective merits of iron and wooden boats; to the advantages of cork fenders carried in the form of bolsters around a boat and below the gunwale. Chocks and releasing tackle would receive attention, gripes and davit guys would also be commented on, and probably for the guys, if these must continue to be used at all, tackles instead of lanyards would be recommended.

The differing situation of boats about vessels' decks is deserving of consideration—some on chocks near to the deck level, and needing to be hoisted several feet to pass over a rail; some kept at rail height, and too high for passengers to get into them; some overhead and inaccessible until lowered outside the rail; and some, like the boats of the *Kaiser Wilhelm der Grosse*, placed upon and close to the upper deck, having no rail either inside or outside of them, themselves constituting a bulwark, and ready to be launched with all the facility attainable where the ordinary davit is in use. Where the simplification of every process means so much, attention may here be called to the double use of the cork bolster put round the lifeboats of the vessel mentioned; this is not only a protection to the boat in case of collision with the vessel or otherwise, but it affords an admirable means for securing and for instantly detaching the canvas cover which ordinarily is fastened over the boat when it is upon the deck.

This cover extends over the sides and down beyond the bolster, and has a loose lacing of small rope rove through grommets upon the edges, a line passing through the lacing along each side the boat is tightened up and the ends toggled together at stem and stern, the effect being to gather the edges of the cover inward under the bolster and to secure it, and again to instantly release and free it when this is desired by slipping the toggle.

The cover in this way is removed intact in very much less time than it could be cut adrift by a sharp knife. Of the various means in use of throwing down the chocks on which the boat rests, or at least of removing the outer ones so that it can be launched, those on the *Kaiser Wilhelm der Grosse* seem adequate, and nothing

could be more simple. Any pressure from wind or from a sea shipped would be from the weather side, and would bear inward. On the inner side the boat is supported by the two chocks in the customary manner, and is held in firm contact with it by the gripes. It is held from moving outward by an iron rod, carried from inboard outward and horizontally through eye bolts on the face of the lower part—the stationary part—of the chock; this rod is turned up at a right angle for a few inches at the outer end in such a way as, when operated from the deck at the inner end, where a lever handle is situated, the outer end is turned up outside the keel and the boat's movement is prevented.

The matter of releasing gear is too important to wholly omit mention of in a consideration of this subject; there can, I think, be little doubt that in rough water, with ship and boat in active movement, the handling of boat falls and hooks is attended with both difficulty and danger, even in daylight—it is, of course, even worse in darkness—whether this be done for the purpose of letting go or of hooking on. It is important that the two ends of the boat be lowered evenly, and that the falls be so rove through the blocks that if one end be let go the other, either by getting foul or being held on to, may not prevent both ends of the boat descending to the water and becoming water-borne. There are many devices for detaching the lower hooks; not all, perhaps equally free from the risk of fouling, or sure of smooth and reliable working. It might be invidious to select one for preference, unless, indeed, from a more intimate acquaintance with the history of its working than I can claim; the U. S. Government and many merchant vessels have however, I understand, made considerable use of one of these which appears to me to be a good contrivance, and is well deserving of attention. I will only say in conclusion that whatever appliances are used should be kept in good working order. If wooden boats are used these should not be dried out and leaky, so that they cannot be kept afloat, as has too frequently happened; boat falls should be of good, pliable rope that will run easily and freely through the blocks without choking and without kinking; and for the rest, if the present means for launching boats in times of difficulty and disaster are not improved upon, and if it should ever again be my misfortune to have a ship go down under me, I hope the temperature and distance may admit my swimming ashore, as otherwise I would rather put my trust in a spar, hatch, or plank, or in anything that might float, than in the likelihood of getting boats properly afloat in any short period of time. I trust that I may here be permitted to suggest that the appointment of a committee from the members of this association to thoroughly investigate and consider this subject would give promise of results such as would be eminently beneficent, worthy of the effort made, and of the Society, and not so well attainable by any other means in sight.

Various exaggerated statements have appeared in the daily press abroad and here regarding the speed attained by the turbine driven destroyer *Viper* on her preliminary trials. It appears to be the fact that no extraordinary speed was reached and that the trials were simply for the purpose of getting the machinery in condition for the full speed run.

OFFICIAL SPEED TRIALS OF THE 30-KNOT U. S. TORPEDO BOAT DAHLGREN.

Probably no vessels built in recent years for the United States Navy have been viewed with such interest by engineers as the torpedo boats *Dahlgren* and *T. A. M. Craven*, built at Bath, Maine. In our issue of September, 1899, we published extensive details of these vessels, especially of the machinery, which in many respects is radically different from the designs most frequently met with. In the engines, notably, photographic views of which we published at the time, the difference of model is very apparent. Instead of comparatively high engines consisting, in effect, of a slender steel framework with a row of cylinders on top and crank shaft and bearings at bottom, there is shown a very compact machine—a concentration of power, as it were. Instead of the familiar turned steel columns there is a framework of manganese bronze, securely bolted to the steel bed plate. The practical value of this form of engine was demonstrated in the recent severe trials of the *Dahlgren*, which were carried out without hitch or slow-down for any defect or derangement of machinery. These trials we here propose to describe. It will be recalled that the *Dahlgren* is of the Normand type, with modifications of design introduced by the builders.

On October 23, at 1.05 o'clock in the afternoon, the *Dahlgren* left the yard of the Bath Iron Works, Bath, Me., for the first part of her official speed test. The vessel was deeply laden, and all the prescribed weights were on board, plus coal and water sufficient to take her to the measured mile off Southport, Me., and also to furnish steam during all the low power runs. The trial board, the builders' staff, and the officers and crew were all carefully weighed as they stepped on board—there were 34 men all told on each of her trial runs. The hull and machinery of the vessel were completed, with the exception of linoleum on deck and the canvas ceiling in the living spaces, and this weight was allowed for. The following are the weights of the *Dahlgren*, together with the trial load specified to be carried on trial:

Hull complete with fittings	44.55	tons.
Machinery complete with steam up	78.20	"
Coal	9.00	"
Crew and effects	2.50	"
Outfit	4.50	"
Ordinance	4.29	"
Total Trial Load	20.29	"
Displacement	143.04	"

The government trial board consisted of Capt. Emory, President; Commander Charles R. Roelker, Engineer; Washington L. Capps, Naval Constructor, and Lieutenant-Commander Henderson, U. S. N. The trials were in charge of Vice-Pres. John S. Hyde of the Bath Iron Works, and the builder's staff included Consulting Engineer Charles E. Hyde, Chief Hull Draughtsman William A. Fairburn, Chief Engine Draughtsman Edward S. Hutchins, and Charles P. Weatherbee.

The *Dahlgren's* official trial consisted of a standardized screw test, which occupied a part of three separate days. On Monday, October 23, the programme called for a progressive trial on the measured mile off Southport, Me., so that the relation between the revolutions of the screw and the speed of the vessel could be accurately determined when the vessel was carrying the full specified trial load. On this day Fort Popham was reached at 1.45 p. m., and at 2.08 p. m. the *Dahlgren* was off the

"Cucholds," she having steamed easily under natural draft at a 17 knot rate. At 2.45 p. m. the *Dahlgren* steamed over the Southport course towards Boothbay, due north, on the first run of the progressive test. In slack water she covered the mile in 2 min. and 47.6 sec., which is equivalent to a rate of speed of 21.48 knots. The mean revolutions per minute were 234 for the two engines. The vessel then made a long loop turn without reducing the speed, and returning she covered the mile in 2 min. 40.25 sec. (which is equivalent to a speed rate of 22.46 knots) with 243 turns per minute. The third run on the mile and the first of the second series gave a mean speed of 24.61 knots, with 265 revolutions. After making a long sweep the *Dahlgren* made the return run in 2 min. 28.5 sec. with 263 revolutions per minute, this time being equal to a speed of 24.24 knots per hour. Run No. 5, which was the third run north, was made in 2 min. 17.4 sec. with 278 revolutions. This performance is equivalent to a rate of speed of 26.20 knots.

The vessel's change of trim was now particularly noticeable. Walking from the quarter deck forward seemed as if one was walking up a steep hill. Flames shot from the stacks, and thick smoke was trailing behind for a distance of at least two miles. There was no disagreeable whipping and racking perceptible, as is frequent on boats of this class. At a speed of 22 knots the vibrations, although slight, were noticeable, but as the speed decreased or increased the vibrations lessened, and at very high speed or at ordinary cruising speed the vibrations were practically nil. After the fifth single run the speed was so great that it was not considered advisable to attempt to turn the vessel at full power, owing to the limited space for manœuvring necessitating great helm angle, and this great angle of the rudder always causes the affected propeller to race. The vessel was therefore slowed down to about 25 knots' speed to make all the turns, which was detrimental to speed with quick-steaming water tube boilers. The sixth run of the progressive trial, which was the third run to the south, resulted in a speed of 27.36 knots with 288 revolutions. the time on the mile being 2 min. 11.6 sec. A long sweep was now made, and the next run north was accomplished in 2 min. 01.6 sec., the speed being 29.61 knots with 313 revolutions. The return run was made in 2 min. 0.7 sec., the speed being practically the same (29.59 knots), and the mean revolutions on the mile 312 per minute.

A fifth double run was about to be made at maximum power, but as it was growing very dark, the builders decided to postpone the full power runs on the mile until the following day. The *Dahlgren*, therefore, was headed for home, having successfully passed through the first stage of her official trial in splendid fashion. She reached Bath about 7 o'clock in the evening, having covered the 21 miles in about 1 hour under cruising conditions with natural draft.

The following day, October 24, the vessel left Bath at noon with the same personnel on board, for the measured base at Southport, to complete the progressive trials and to continue the turning and manœuvring tests. The trials were not quite as interesting as those of the previous day, but greater speed was shown and the vessel dashed over the mile in just 2 min., the counters showing 317 revolutions. Several runs were

U. S. TORPEDO BOAT DAHLGREN TRAVELING AT A HIGH RATE OF SPEED NEAR BATH, ME.

made at rates of speed varying from 30 upwards, and a run at 27 knots checked the data taken the previous day. The vessel behaved splendidly. At top speed she seemed to make much less fuss cutting through the water than she did at 26 to 27 knots. The forefoot lifted almost out of water, and the origin of the bow diverging wave seemed to be near the forward conning tower. No flames could be seen shooting from the stack, but the vessel went forward at railroad speed. The speed on all the vessel's measured runs was increasing all the time she was on the mile, showing that the remarkable speed attained was no "bottled up" spurt performance.

The vessel was given two ten-minute runs in the open sea as a preliminary canter for the one-hour's sea run that was to follow. The first 10 min. gave a mean speed of 30.4 knots, and the second 10 min. trial resulted in a mean speed of 30.6 knots. As the afternoon was now well advanced, the builders decided to return to Bath, where they arrived about dusk.

The trial board were summoned to the Charleston Navy Yard Tuesday night to inspect the training vessel *Chesepeake* in dry dock, so it was not until Friday, Oct. 27, that the official trial of the *Dahlgren* could be concluded. In the meantime the wind had been kicking up a nasty sea, but as the prospects were not good for fair weather in the near future, the builders decided to risk running her for an hour or more in the open sea under what would be considered, for this class of boat, very unfavorable conditions. In that region towards the end of October continued good weather cannot be expected, and as the fall and winter advance the sea get less and less suitable for high speed runs with small, light boats. The builders had either to run the vessel on her trial and make the 30 knots in an hour as required, or else pay a heavy penalty for delay in completing the vessel, and of the two evils they considered the former the lesser. The *Dahlgren* accordingly left Bath at 7.30 o'clock on the morning of Oct. 27. She arrived two miles beyond Seguin an hour later, and at 9 o'clock she was headed southwest for the Isle of Shoals. The board was notified that all was in readiness for the official speed test.

The vessel did not respond to the order of full speed ahead as rapidly as she usually does in smooth water. The machinery had to be "limbered up" somewhat, and, therefore, the first observation taken gave the vessel a speed of only 27.5 knots. In a nasty quartering sea that caused the little vessel to roll badly and throw water all over herself she gradually increased her speed. After running fifteen minutes the observations showed that she was traveling at a 29.5-knot gait. The flat knuckle stern and the high speed of the boat kept the wheels from racing, but the sea and wind were a great handicap. Gradually the speed increased, and after traveling about one-half hour the speed had risen to 30 knots. The sea was growing worse all the time, but the boat's complement worked without remission. On two occasions the speed reached 30.8 knots, and the best time was being made when the orders were given to slow down. The vessel had steamed at full power for about 100 min. The mean rate of speed attained was 30.05 knots, a really wonderful performance for a small high-speed boat in a rough sea.

After successfully passing through severe turning and steering gear trials the *Dahlgren* put into Portsmouth, N. H., where she remained until Sunday, Oct. 29, when the weather had moderated sufficiently to warrant making the return trip to Bath. All on board were enthusiastic over the performance of the little vessel, for she passed through the severest tests without a flaw being discovered. On her first attempt at an official trial she proved successful, and although greatly handicapped by most unfavorable conditions of wind and sea, she slightly exceeded her designed speed of 30 knots.

There has never been any breakdown or accident aboard the vessel, and the hull and machinery have stood the stresses of preliminary runs and official tests without exhibiting any defects. A speed of 30 knots in a heavy sea on a displacement of 140 tons, 15 per cent of which is trial load, is a remarkable performance; but when it is remembered that this speed was obtained with a piston speed of only 1,100 ft. per min., and less than 320 revolutions, and moreover that 4,200 I. H. P. were gotten out of two boilers, the results seem almost beyond present possibilities. Yet they are official and undisputed.

U. S. STANDARD LIFEBOAT PROPELLED BY GASOLENE ENGINE—SEE PAGE 22.

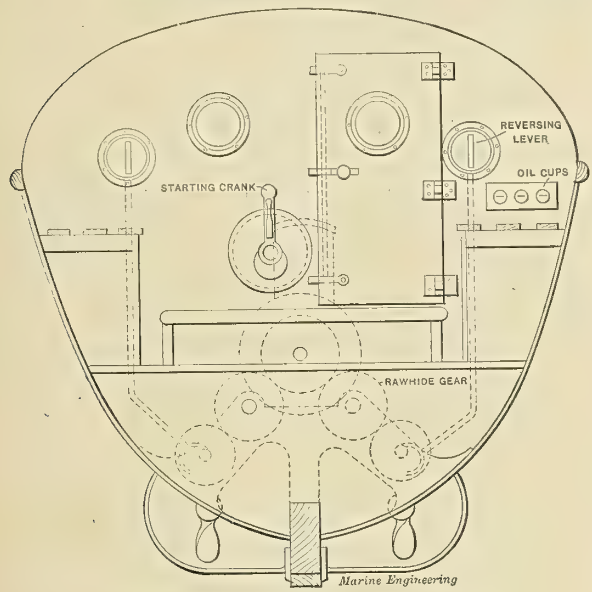
S. S. Pennsylvania.—The freight and passenger steamship *Pennsylvania,* of the New York, Philadelphia and Norfolk Railroad, was launched from Roach's yard, Chester, Pa., December 16. This vessel is of the following dimensions: Length, 260 ft.; beam, 40 ft.; draft, 9 ft. 9 in. She is very fully powered, and is expected to attain a high rate of speed for a vessel of this class. She will run between Cape Charles, Old Point Comfort and Norfolk.

TWIN SCREW LIFEBOAT FOR THE U. S. LIFE SAVING SERVICE.

BY LT. C. H. MCLELLAN, R. C. S. ASST. INSPECTOR.

There are two principal classes of boats used in the United States Life-Saving Service, the lifeboat and the surfboat. The lifeboat, because of its great weight, 6,000 to 10,000 lb., is located where it can be launched into comparatively smooth water from a cradle, as in the harbors of the Great Lakes, and is propelled by oars and sails, or assisted by a tug boat to the vicinity of the wreck. The surfboat, weighing from 1,200 to 1,500 lb., is placed at all of the coast stations, and is easily transported along the coast on specially constructed carriages to a point nearest the wreck, and then launched from the beach. The surfboat is also supplied to all of the Lake stations. The lifeboat is propelled by ten oars, pulled double bank, and three sails. The sail plan is small and heavy, as it is mostly used in heavy winds.

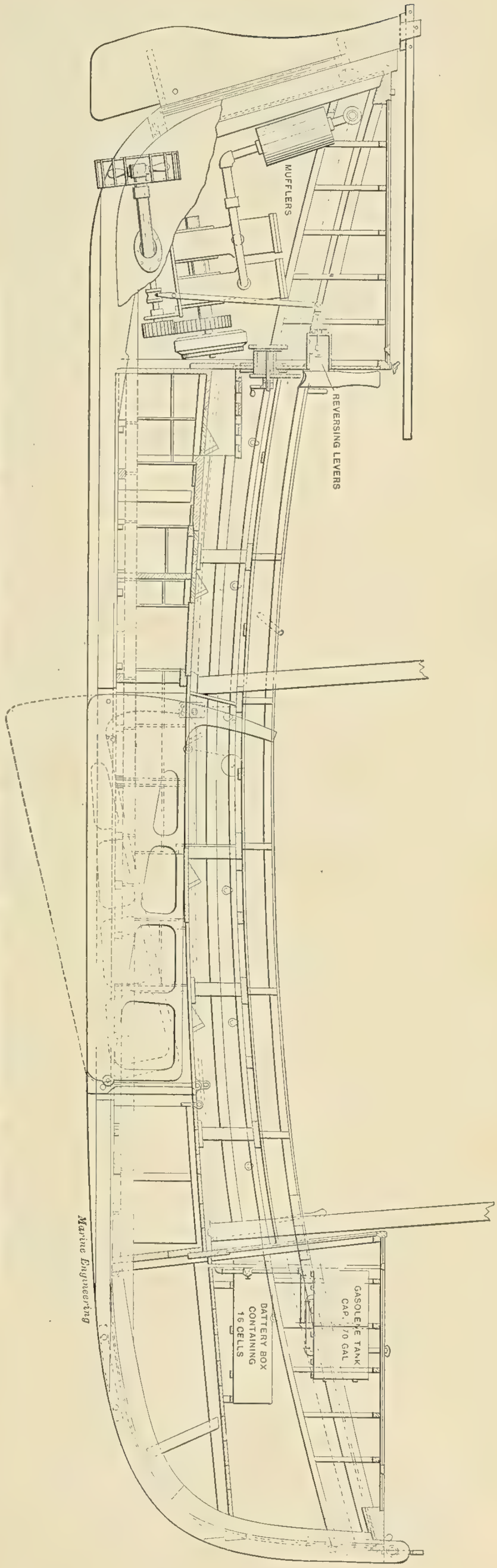
If the vessel in distress is a considerable distance from the lifeboat station the assistance of a sea-going



ENLARGED SECTION AT AFTER BULKHEAD.

tug is usually necessary to tow the lifeboat to the vicinity of the wreck, when the tow line is dropped, and the lifeboat manœuvred to get within reach of the wreck and make the rescue. Usually, if the conditions will permit, the lifeboat is dropped to windward and pulls down to the wreck and takes off the crew, and in the meantime the tug has steamed to leeward of the wreck, where the lifeboat joins her after the rescue. This process is necessary because of the great weight of the lifeboat and the difficulty in pulling her against a wind of any force. It consumes much time, which is augmented in many cases by waiting for the tow boat to get up steam, or from there being no tug immediately available.

The necessity for a lifeboat with power has long been recognized, both in this country and in Europe, but because of the peculiar work required of the lifeboat the problem has been difficult of solution. The British Royal Lifeboat Institution has been working on this problem for several years, with doubtful success, having built



LONGITUDINAL SECTION OF U. S. STANDARD 34-FT. LIFEBOAT, PROPELLED BY TWIN SCREWS DRIVEN BY GASOLENE ENGINE.

several steam lifeboats;* but in the opinion of many the mistake has been made of building their boats too large, they being, in fact, seagoing tugs. The lifeboats of the U. S. Service are made self-righting, as they are used in surf which can, and frequently has, capsized them. A boat with steam power, if capsized and rolled completely over, would have but little assistance from its engine afterwards. Experiments have recently been made by the U. S. Life-Saving Service with a gas engine as the motive power, and with very gratifying results. The Service 34-ft. lifeboat was selected, the largest class in use, and in this a 12 H. P. "Superior" gas engine was placed. This engine was selected because of its lightness per horse power, simplicity of construction, compactness, and its ability to run under adverse conditions. It is also arranged to turn two propellers with one engine.

The engine, with the gears and attachments of the two propeller shafts, is installed wholly within the after air chamber, the only portion of the machine on the outside being the two reversing levers, the end of the starting shaft, and the oil cups. The parts outside of the air chamber are in recesses in the bulkhead, out of the reach of ropes or other dangers, as shown in the accompanying drawing. The engine was installed without disturbing the construction of the boat. It was passed through an opening 16 in. by 16 in., and set up on the inside. The air chamber is 6 ft. long and 6 ft. wide at the gunwale of the boat, tapering to a few inches at the keelson and stern post. The engine weighs 1,350 pounds, is of the two-cylinder type, having an explosion every revolution, the spark being produced by sixteen portable rubber cell batteries. The engine cylinders are 6 in. by 6 in., and the speed of revolution is 400 turns a minute.

There are two 18 in. propellers, having two reversible blades each, the reversing levers being connected to pulls leading through stuffing boxes in the bulkhead. The propellers are protected on the outside by suitable cages. The cylinders are lubricated by automatic oil pumps, and all other bearings by cups placed in a recess in the bulkhead, and accessible from the outside.

Air is supplied to the engine through two 2 1-2 in. brass pipes leading from the top of the inside of the air chamber, down the bulkhead, and opening through it 6 in. from the deck. If the boat should be upset these openings will be in the air space under the boat, and out of the reach of the water.

Gasoline is stored in the forward air chamber and as high as the roof will allow, the gasoline being carried to the engine by gravity, dispensing with the pumps and their different parts so apt to become clogged and fail at a critical moment. The tank in the boat under trial has a capacity of 75 gallons, though there is room in the air chamber to carry a much larger tank if necessary. To prevent the fuel from being cut off from the engine by reason of the extreme pitching of the boat, as might occur in a very heavy surf when the stern is on a high sea, a small reservoir is attached to the engine through which the gasoline flows to the engine. The engine consumes 2 gallons of gasoline an hour when under the full speed of 7 1-2 miles per hour, at an expense of about two cents an hour per horse power.

* An illustrated description of a hydraulic propelled lifeboat was published in the issue of January, 1898.—Ed. M. E.

The batteries are sealed, and carried in a drawer fitting into a close case in the forward air chamber, having its only opening in the bulkhead. By this arrangement the batteries must be removed from the air chamber for any needed attention, thus removing all danger of accident form a spark caused by ignorant handling of the wires.

Provision has been made for cutting off the supply of fuel from the engine in case of a capsize, thus stopping the engine. This is advisable, for without this precaution, if the lifeboat was upset, and the crew thrown into the water, the boat would right almost instantly, and the engine being in motion, would run away from the crew before they could climb into the boat. Another reason for stopping the engine during an upset is the danger from having the passengers and crew thrown into the water with the two propellers running at a high speed in the vicinity. The self-righting qualities of the lifeboat have not been injured by the addition of the weight of the engine. In the tests made she righted from even trim bottom up to even trim right side up in 3 sec.

In these tests the boat attained a speed of 7 1-2 miles an hour over a measured course. She reversed from full speed ahead and had sternway on in 20 sec. With one propeller going ahead and the other astern, she turned in a circle 50 ft. dia. The boat was tested under sail and power during a gale blowing at the rate of from 28 to 40 miles an hour, as registered at the Weather Bureau. She was taken 5 miles outside of the harbor of Marquette, Mich., and tried under all directions of wind and sea, and behaved as well as could be desired. Under the same conditions of wind, and without the engine, a tugboat's assistance would have been necessary, or several hours consumed in beating the lifeboat out against the wind.

It is the unanimous opinion of the officers of the Service who have witnessed the trials of this boat that the Service would have a very valuable auxiliary by its general adoption.

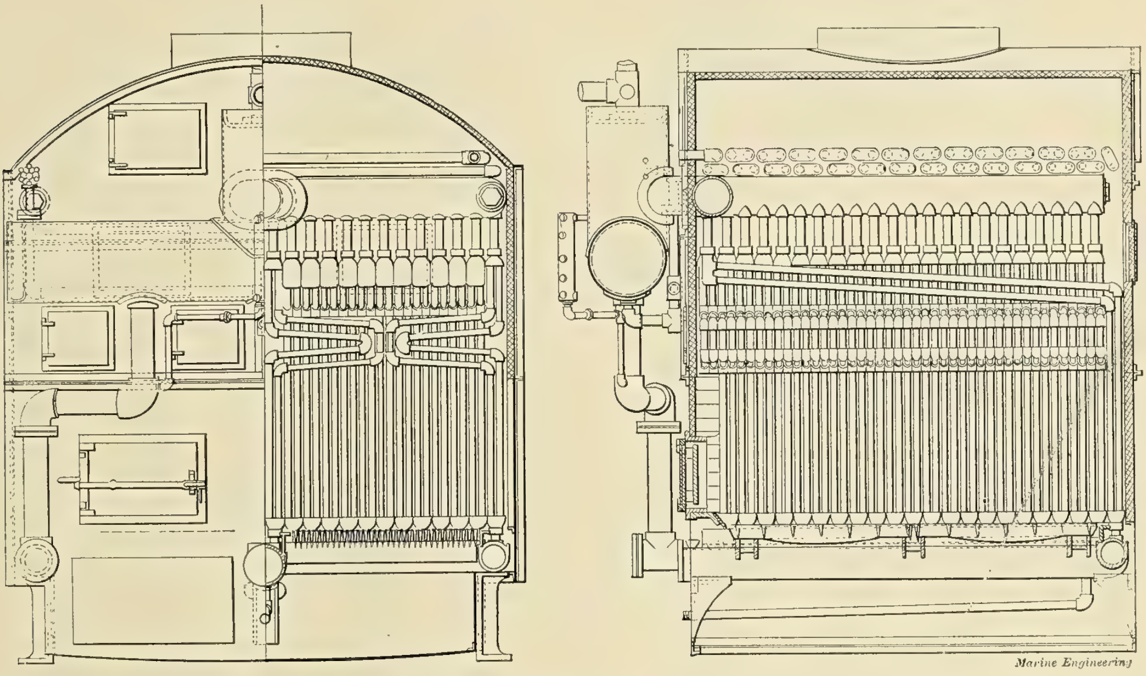
U. S. S. Bailey.—The torpedo boat destroyer *Bailey* was launched into the Harlem river from the yard of the Gas Engine & Power Co., and Charles L. Seabury & Co., Consolidated, New York city, on December 5. The boat was christened by Miss Florence Beekman Bailey, grand-daughter of the late Rear-Admiral Theodorus Bailey after whom the boat was named. An artistic silver loving cup is to be presented by the family of Rear-Admiral Bailey, upon which a suitable inscription referring to the services of the Rear-Admiral under Admiral Farragut will be engraved. The *Bailey* is one of the three boats authorized by act of Congress of March 3, 1897. She has hitherto been classed as a torpedo boat destroyer, but is now placed in the list of torpedo boats of the Navy. The other two vessels authorized under this act are the *Goldsborough,* building at Portland, Ore., and the *Stringham*, which was launched some time ago at Wilmington, Del. The *Bailey* is of the following dimensions: Length, 205 ft.; beam, 19 ft. 2 in.; mean draft, 6 ft.; displacement, 235 tons. She is fitted with twin screws, driven by triple expansion engines of the builder's design, which are expected to develop 5,600 horse power. Her estimated trial speed is 30 knots. The armament of the boat will consist of two 18-in. Whitehead torpedo tubes and four 6-pounder rapid fire guns.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—I.

DESCRIPTIONS OF THE ALMY, SEABURY AND NICLAUSSE BOILERS WITH SECTIONAL DRAWINGS.

Almy Water Tube Boiler.

The Almy water tube boiler is composed of a series of straight lengths of tube, both vertical and horizontal, joined together by suitable bends, elbows, etc., with screwed connections. In detail the "single tube" boiler of this type is composed of a continuous manifold at the base, extending along each side and across the back below the grate. At the top of the boiler a similar manifold extends along the sides and across the front and is there connected to the vertical steam dome situated outside the casing. The heating surface is formed by a series of sections composed of tubes connected together by elbow return bends and Y fittings, which are connected to the top and bottom manifolds by unions. The sections at the sides rise straight from the bottom manifold, for a distance, to form the crown of the firebox, and then turn inward, extending half way across the firebox, returning again back to the sides and thence straight up again until they connect with the top manifold. The sections which form the back of the furnace rise from the back bottom manifold to a height sufficient to cross over above and at right angles to those that form the crown of the firebox. On reaching the front they return back again and then to the front again, and are connected to the top manifold, which extends across the front. The several sections form the heating surface. In the double tube boiler the same general design is followed, with the addition that there are two rows of tubes forming the greater portion of the sections of heating surface instead of a single row at the sides and back, as in the single tube type. The feed heater or economiser consists of one or more layers of tubes connected together by screwed return bends, forming one continuous tube, and it is placed over the top manifold. This top manifold is connected with the vertical separator or steam drum fitted in front of the boiler, and this drum is riveted at its lower and open end to the horizontal water reservoir which extends across the front over the fire doors outside the casing. Down flow tubes on each side lead from the reservoir to the bottom manifold. Water circulation is as follows: The feed enters the heater at the top, and after passing through the heater tubes enters the boiler at the bottom of the horizontal water reservoir and flows through the down cast tubes into the lower manifold; thence up through the generating tubes and in the form of steam passes through the top manifold into the separator. There the entrained water is separated and falls into the water reservoir, thus getting into circulation again. The water level is maintained about the middle of the horizontal water reservoir. The blow off is connected in the mud drum which is a part of the lower manifold near the center at the back of the furnace, this being the lowest and quietest place in the boiler. Heating surface ratio of this type varies according to various changes in interior dimensions, number of sections of feed heater and also where two furnaces are employed. In stock sizes, however, it ranges from 25 sq. ft. heating surface to 1 sq. ft. grate surface, to 40 to 1. The tubes are stated by the builders to be of "the best quality of metal," the manifolds and tube connections of air blast malleable iron, and the steam dome and water reservoir of lap welded tube. All Almy boilers are built for a working pressure, of 250 lb. per sq. in. They have been extensively

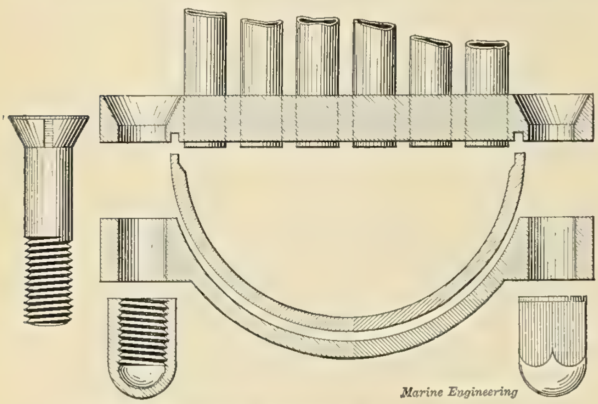


ALMY WATER TUBE BOILER.—FRONT AND SIDE ELEVATIONS.

installed as main and auxiliary boilers in yachts, tugs, ferryboats, steamers, launches and for stationary purposes. The boiler is manufactured and marketed by the Almy Water Tube Boiler Co., Allen's avenue, Providence, R. I. In the accompanying engraving a two furnace Almy boiler is shown.

Seabury Water Tube Boiler.

The Seabury boiler is of the small bent submerged tube type, consisting of a central water and steam drum situated over the furnace and connected by bent tubes with two half manifolds at the bottom, one on each side of and below the grate. The tubes are expanded in place at both ends. The tubes are arranged so that they have the same width of opening between them as their diameter, and by the use of a fire-brick baffleplate the gases are made to flow over the entire upper portions of the tubes. The drum is of plate with riveted joints, and is provided at the front end with a manhole of large size. The half manifolds at the bottom are

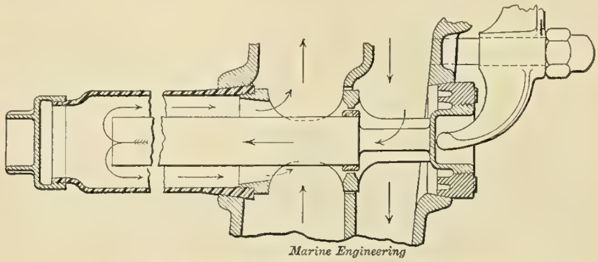


DETAIL OF LOWER MANIFOLD, SEABURY BOILER.

welded up and their top edges are machined true, fitting a groove in the under side of the bottom tube plate. The joint is made by asbestos wick in the groove, and the half manifold is drawn up to the packing by steel bolts and straps. The heads of the bolts are countersunk on the top side of the tube plate, leaving it a smooth surface, so that it can easily be cleaned. Details of construction can be readily gathered by an inspection of the accompanying drawing. On top of the boiler tubes proper there is placed a feed water heater, consisting of straight iron pipes lying parallel with the central drum and connected at the ends with malleable iron screwed return bends. The gases from the combustion chamber pass over these heater tubes before reaching the stack. Wrought iron grate bars of the shaking type are used, and the boiler can be arranged to burn either hard or soft coal or wood. When the boiler is filled ready for operation and the fire is lighted, the heat coming first in contact with the inner row of tubes causes an upward movement of water in these tubes toward the drum. As the heat increases the water in the other rows of tubes follows the same direction, with the exception of the outer rows next the casing. In these the flow is downward to the lower side manifolds, and thus a large area of pipe for returning the water from the upper drum is secured without the use of outside down-flow tubes. Advantages claimed for this system are that the water leaves each side of the upper drum along its entire length and has a comparatively short distance to travel to get back again; also that each tube takes care of its own supply and is not dependent upon any other tube or contrivance for its efficient operation; also, the distance between the tube ends is so small that "the water is practically in circulation in the tubes," and with the free circulation of water sagging of tubes is avoided. It is claimed also that great steadiness of water level is secured, so that when in operation the variation of level would not exceed one inch from standing still to full speed of engine. In larger units a somewhat different design is adopted. In this the central drum is retained, but instead of the half manifolds, steel drums, one at each side, are employed. There is also a vertical row of straight and slightly curved tubes connecting the bottom of the steam drum, its entire length, with a tube of large diameter at the grate level. This center row of tubes divides the grate into two equal sections, making two separate furnaces. This type of boiler is manufactured by the Gas Engine & Power Co., and Charles L. Seabury & Co., Consolidated, Morris Heights, New York City. It is widely used in yachts and launches, and is now being fitted by the builders in the U. S. destroyer *Bailey*, which they have under construction.

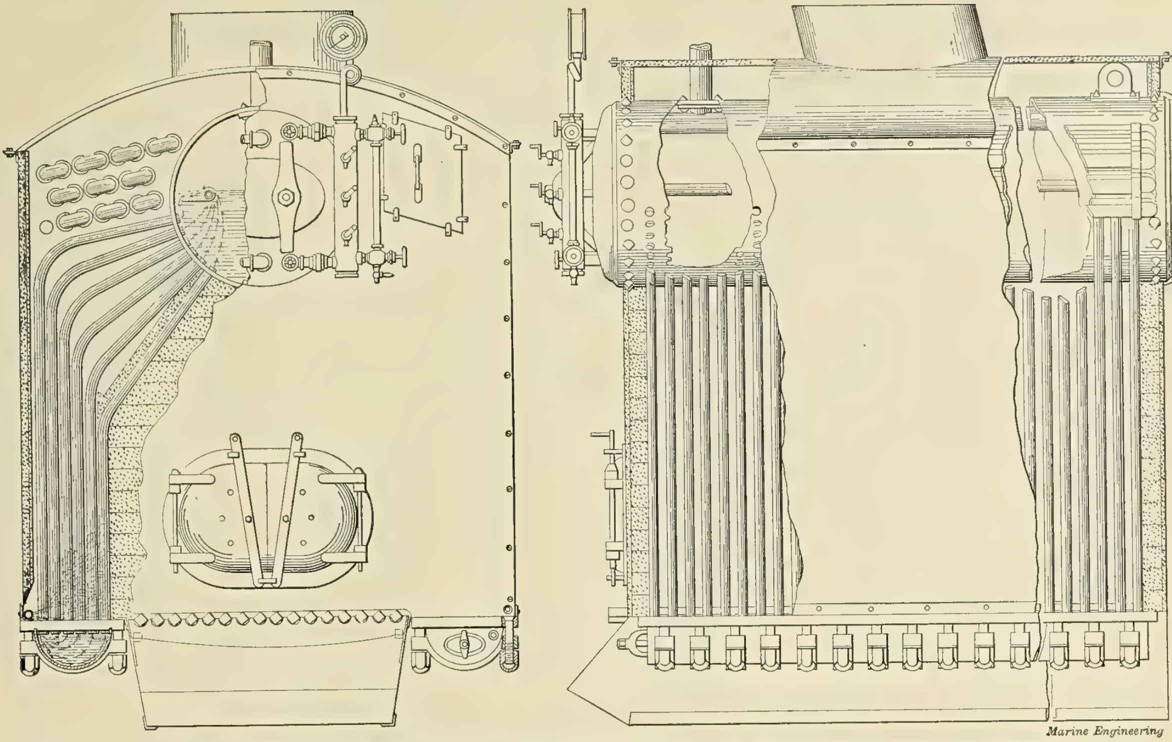
Niclausse Water Tube Boiler.

The Niclausse boiler is of the large straight tube type. "Field tubes" set at an angle of six degrees to the horizontal, are all placed above the grate and are connected at the front and back with vertical headers. The front row of headers is connected at the top with the horizontal steam and water drum which extends across the boiler. The headers are arranged as shown in the accompanying drawings, and are interiorly divided into compartments, as can be seen by reference to the detail sectional drawing. Each tube consists of a pair of tubes placed concentrically, the outer or generating tube being upset at the front end to a diameter slightly greater than that of the tube, and this thickened end is machined so as to accurately fit the tapered tube hole in the rear face of the front header. The back or dead end of the outer tube is swedged and sealed by a steel cap of a diameter slightly less than that of the tube. Attached to the generating tube is a sleeve provided at its outer face with a flexible tapered joint which fits the tapered socket in the front face of the header. This sleeve also contains a smaller

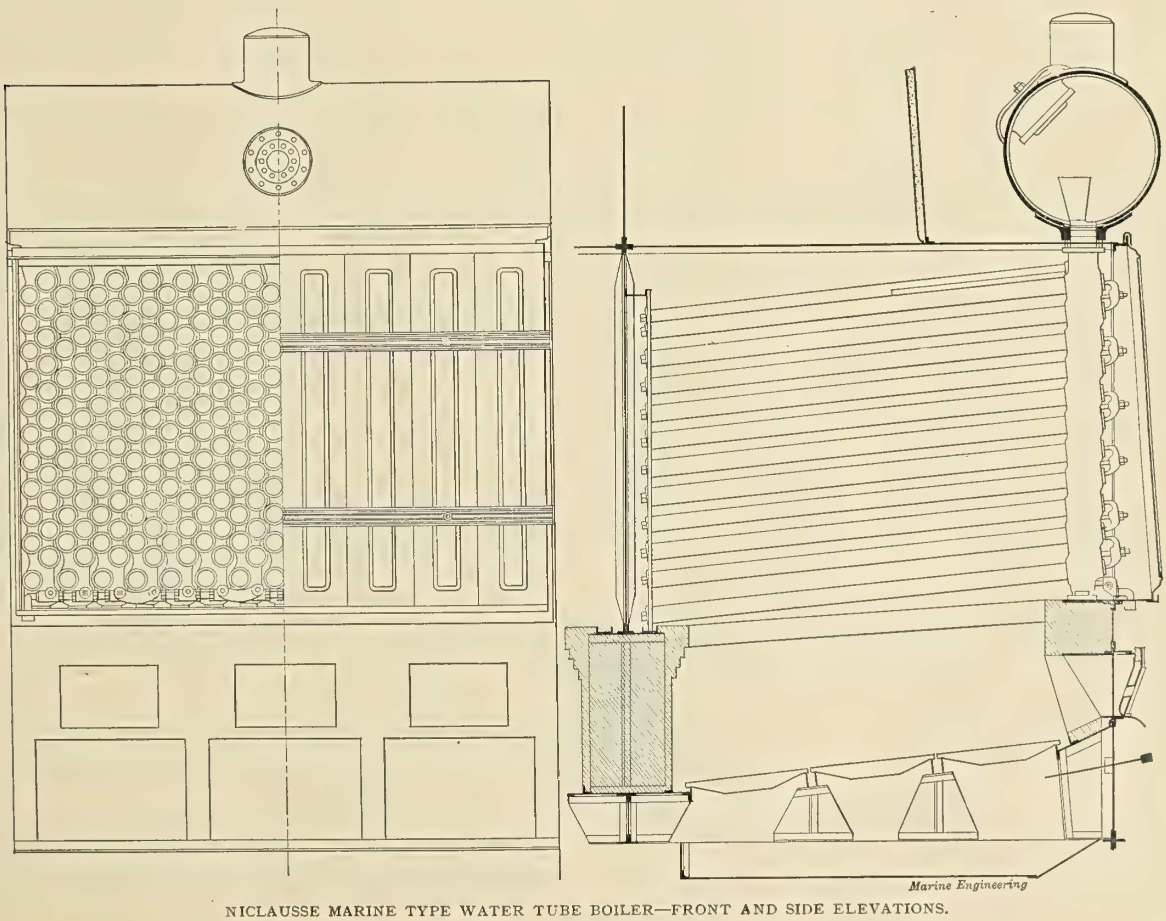


SYSTEM OF CIRCULATION, NICLAUSSE BOILER.

sleeve holding the inner or circulating tube, and the whole—consisting of the outer or generating tube, the main sleeve and smaller sleeve and the inner or circulating tube—is held in place by a dog and studbolt. In the construction expanded joints are eliminated, and



SEABURY WATER TUBE BOILER—FRONT AND SIDE ELEVATIONS WITH CASING PARTLY REMOVED.



NICLAUSSE MARINE TYPE WATER TUBE BOILER—FRONT AND SIDE ELEVATIONS.

the tendency of the pressure when under steam is to tighten rather than strain the joints. Speed in making repairs is claimed for this type. To renew a tube it is only necessary to loosen the dog and withdraw the tube through the front header; then to pass in the new tube, so that the tapered joint of the upset portion of the tube, and the tapered flexible joint of the main sleeve are brought face to face with the tapered faces of the rear and front sockets of the header, and then to clamp the dog in place again. When under steam the feed water enters a tray in the front of the steam and water drum, and is there heated to the temperature of the steam. Overflowing into the drum the water descends to the front compartments of the headers and passes in solid streams down the inner or circulating tubes to the extreme ends of the "field tubes," and here it turns and passes back to the front in the annular space between the inner aud outer tubes. The mixed steam and water then passes upward through the inner compartments of the headers and discharges into the drum. By an arrangement of baffling plates the gases are made to circulate in an S-shaped path among the tubes, on their way from the furnace to the uptake. The boiler is of French origin and has been used extensively in the French and Russian navies. It is manufactured in this country by the Stirling Company, Pullman Building, Chicago, Ill. The boiler shown in the drawing is one of a set recently completed for installation in a Russian warship under construction at Cramp's. Claims made for this type are, among others: Simplicity and accessibility; ease of maintenance and repair; positive circulation; responsiveness to fluctuations in power; dryness of steam; and economy. The design can, of course, be altered to suit special structural conditions as to installation or transportation.

TRANSATLANTIC MAIL SERVICE.—The continued withdrawal of vessels from the transatlantic service, for use by the British Government as transports during the Transvaal war, has seriously disturbed the regular mail schedules. Large quantities of mail which would have ordinarily come through New York have been sent via Boston by the slower steamers on that route. In consequence of these withdrawals the Cunard line is now obliged to maintain its New York service with only three vessels, the *Campania, Lucania* and *Etruria*. The White Star line has to depend on the *Oceanic*, the *Teutonic* and the old *Germanic* for her mail and passenger service. The American Line is rather crippled also by the temporary loss of the *Paris*. How long this condition of things will last is not apparent, as from present appearances the Transvaal war will be a lengthy affair.

January 3 has been set for the launching of the new Hamburg-American liner *Deutschland*, which is designed to be the fastest liner afloat. She is of 23,000 tons' displacement, and is expected to have a sea speed of 23 knots.

The new Cunarder *Saxonia*, for freight and passenger service on the Boston-Liverpool route, was launched at the Clydebank yard December 16. She will have immense cargo-carrying capacity and moderate speed.

The navy is now short about 4,000 men of the 20,000 allowed by law.

BOILER ARRANGEMENTS OF RECENT BRITISH AND FOREIGN CRUISERS.*—II.

BY F. T. MARSHALL, MEMBER.

Next dealing with the question of boiler-room work, we find that, on the basis of the natural-draft power, the two water-tube types are substantially lighter than the cylyindrical type, the Yarrow type being the lightest. On the basis of the maximum power the advantage of the Yarrow type in this respect is enormous, whereas the Belleville type is not materially lighter than the cylindrical, owing to the fact that it is not forced. Thus, on a given weight, the Belleville type will develop, with natural draft and for long periods, approximately the same power that the cylindrical type will develop for short periods of a few hours under extreme forced draft. Also, on the same weight, the Yarrow type will develop 14 per cent more than the Belleville for long periods, and 78 per cent more for short periods. Again, comparing the Yarrow with the cylindrical, it is seen that it will develop 50 per cent more power for long periods, and 65 per cent more for short periods, on a given weight.

These comparisons are based upon total boiler-room weights, including water in boilers plus water in the feed tanks, and also such fittings as reducing valves, separators, etc., which form an intrinsic part of the boiler systems. The separate weights of boilers and funnels, water, and boiler-room accessories are also given, and it may be noticed how relatively high the weight of accessories is in the case of the Belleville type, owing to the numerous special fittings which form part of this system.

FORCED DRAFT.

A crucial point in the above comparisons of space occupied and weight is the question of how far forced draft can safely be used in the usual exigencies of service, or even in the extreme case of war. As to the Yarrow boiler, the writer submits that, as far as the boilers are concerned, this type may safely be forced to an air pressure of, say 2 in. (the maximum employed on the *Don Carlos* trials) so long as the coal lasts. Working under these conditions is, however, very severe on the personnel of the stokeholds, and the endurance of the men would probably be found to be the measure of the time during which this power could be maintained.

In the case of the cylindrical boilers a four hours' run is probably as long as these boilers could be worked at the maximum forced-draft power. These boilers have a tendency to suffer in the flame-box seams when long firebars are used, and it is only by the use of these long bars that the high powers looked for can be obtained. The tube ends also get choked up, especially if fitted with ferrules, and without ferrules the tubes have a great tendency to leak. It is probable that at the end of four hours the boiler efficiency will be seriously affected, and the power could not longer be maintained. On the other hand, however, the high speed obtained during these four hours might mean the salvation of the ship, and it is unfair to overlook this advantage.

*Paper read before the Institution of Naval Architects, England.

It should be understood that the above remarks do not apply to forced draft applied to cylindrical boilers with moderate length of firebar, say 5 ft. 6 in., and with a heating surface of 2 1-4 ft. per indicated horse power. Such boilers can be worked at about 17 indicated horse power per square foot of grate continuously at sea; but their size and weight would preclude their use in the type of vessel considered, as the power obtained would only correspond approximately to the results obtained in the 1-2 in. air-pressure trials of warships.

RAISING STEAM.

The rapidity with which steam can be raised, and the ready response to sudden demands in variation of power, are two matters of utmost importance in war vessels, and in both of these the water-tube types show a marked superiority over the cylindrical boiler. The large quantity of water contained in the latter makes it a question of hours to raise steam; and, if this operation in hurried, the boilers are strained to a serious extent, causing leakage. The same course of reasoning applies, though to a less degree, to any sudden and rapid large variation of power.

As to the two water-tube types, in both cases steam can be raised to full pressure in about thirty minutes from lighting fires. In the matter of variation of power there is also little to choose between them; for, although the large grate area of the Belleville type is an advantage, the safety with which the Yarrow type may be suddenly forced compensates for it.

LIABILITY TO DERANGEMENT IN WORKING.

In this respect, apart from the difficulties mentioned under extreme forcing, the cylindrical type is to be preferred. All the arrangements, both of the boiler itself and of its accessories, such as the feed and steam-pipe systems, are simpler than in the water-tube types. The boilers are fewer in number, thus reducing the number of pipes and connections, and the consequent liability to leaky joints, etc. The feeding is also less critical, owing to the large water level. In addition to this, the introduction of salt water, even in considerable quantities, owing to leaky condensers or other causes, has little appreciable effect upon the working of the boilers. Although, to obtain maximum results, these boilers must be in a state of thorough repair and cleanliness, they are still serviceable after considerable neglect such as would render any water-tube type useless.

With regard to the Belleville boiler a grave objection, in the writer's opinion, is the enormous mass of mechanical detail in connection with them. Thousands of joints, all dependent upon extreme accuracy of workmanship, and many of them subject to extreme strain, due to varying temperature, are a pronounced feature in the design of this type. These points have been well met in the methods of manufacture, but most rigid supervision is required to maintain the accuracy necessary. The feeding is also extremely delicate, owing to the small quantity of water contained, and also variable weight of this water at different rates of evaporation. This latter condition necessitates the introduction of the hotwell pumps and large feed tanks already described. The feed regulator employed, which certainly works admirably, is nevertheless, a delicate mechanism, and has to be kept in a high state of efficiency. The number of boilers is also great for the power developed. This large subdivision has the advantage of involving only a small reduction of power, should one boiler become inoperative for any reason; but it certainly causes an enormous addition of important detail, such as feed-pipe and steam-pipe arrangements, all requiring care and attention. The furnace air-pumping engines are also an additional complication, involving many extra fittings. Whether these objections are valid, extended experience alone can show, and it is an unquestionable fact that the vessels fitted with these boilers, especially since the addition of economizers, have passed through most severe trials with consistent success.

Referring to the Yarrow type, the construction in this case is extremely simple. None of the riveted seams are in direct contact with the fire, and the strains due to changes of temperature are not severe on the parts of the boiler under pressure, especially if the outer rows of tubes are curved. The casings are probably the most severely tried part of the boilers, but no trouble need be feared from these, if carefully designed.

The great question about this and other small-tube types is the life of the tubes, owing to their comparative thinness. Any information which any gentleman could give us on this point would be of extreme interest.

The tubes of the *Don Carlos,* as before stated, are .128 in. and .104 in. thick for the 1 3-8 in. and 1 1-3 in. tubes respectively. They are galvanized externally only, as is usual for this class of boiler in the British navy. Mr. Yarrow, on the other hand, invariably galvanizes the tubes both internally and externally, but this does not appear to be necessary in the case of a boiler with drowned tubes. It is probable that one cause of wasteage on the outside of the tubes is the method of steam cleaning usually adopted in these boilers. This steam jet leaves the tubes damp, which naturally aggravates any tendency to rust. In the *Don Carlos* the tube-sweeping arrangement was taken from the compressed air pipes used in connection with the armament. This gives a perfectly dry air jet at high pressure, and proved a most efficient cleaner without the above objectional feature. The feed system already described has the disadvantage of a large number of pumps, but in all other respects is very simple and unlikely to become deranged. The area of water level also is large relatively to the quantity of water in the boiler, and this area is naturally the measure of the difficulty of steady feeding.

As to the possibility of working with salt water as make-up feed, our experience has certainly been against it in both the water-tube boilers considered. A serious tendency to prime, except at very low powers, is produced by even a small admixture of sea water, and anything approaching continuous use would be, in the writer's opinion, most undesirable. This is evidently borne out by experience, as the Admiralty have recently taken special precautions in all their vessels to minimize the risk of salt water entering the boilers through inadvertance, or without the special knowledge of the officers in charge.

FACILITY OF OVERHAUL.

In this respect the Belleville type has a great advantage, viz., the readiness with which complete elements can be taken from the boiler, repaired in the stokehold, and replaced. The other parts of the boiler are also of

small dimensions, and, in case of a serious accident, the whole boilers can be taken out of the ship through the usual air casings without disturbing decks, etc., and with very slight derangement of even the minor fittings. The examination of the inside of the tubes, however, involves breaking and re-making a large number of joints.

As to the Yarrow type, the operation of renewing a tube is by no means difficult, although if the defective tube is in the middle of a nest, all the tubes between it and the outer edge of the tubeplate must also be removed. The method adopted is to work the tubes from hole to hole alternately between the two tubeplates until the outer edge is reached. If, however, time is of importance, the tube ends can be plugged and steam raised again rapidly without any injury to the structure. The inside of the tubes can be readily seen through and cleaned, owing to their being straight. This examination is merely a question of minutes, and thus is likely to be more frequently made than if considerable time and trouble were needed. It also involves the breaking of no joints, except the manhole doors. The outsides of the tubes are certainly not easily examined, and it is wise from time to time to remove a tube here and there to judge of the condition of the remainder. In the case of a serious accident, or serious neglect, necessitating the retubing of a large portion of the boiler, the process would doubtless be slow. It is not a contingency likely to arise, and in any boiler would necessarily be a dockyard repair. Referring to the cylindrical boiler, the capabilities of this type for ordinary examination and overhaul are well known. For heavy repairs, however, such as renewing a furnace or flame-box, the process is both tedious and costly, and in the extreme case of removing a boiler from the ship the whole of the protective deck and superstructure in way of the boilers has to be removed.

STEAM PRESSURE.

With the water-tube types, the pressure of 300 lb. per sq. in. is now customary. Such pressures are not practicable, except with water-tube boilers, without enormous increase of boiler weight, and they have the advantage of enabling smaller engines to develop the necessary powers, with the attendant advantage of relative economy at low powers. In cylindrical boilers the best balance of weight, power, and space economy appears to be obtained by using about 155 lb. steam pressure. The additional economy in the engines, by using such higher pressures as are possible with these boilers, is not sufficient to justify the additional weight of boiler due to such higher pressures in vessels in which coal consumption is to some extent of secondary importance.

COMPARISONS OF BELLEVILLE, YARROW, AND CYLINDRICAL BOILERS.

Name of Ship	*Andromeda.*	*Hermes.*	*Don Carlos I.*	*Hai Chi*	*Æolus.*	*Pallas.*
Number and type of boiler fitted	30 Belleville	18 Belleville.	12 Yarrow.	8 cylindrical 4 D.-E. and 4 S.-E.	5 cylindrical 3 D.-E. and 2 S.-E.	4 cylindrical D.-E.
Steam pressure in pounds per square inch	300	300	300	155	155	155
I. H. P. with natural draught*	16,500	10,000	8,000	12,000	7,000	5,000
" " forced draught	......	......	12,500	17,000	9,000	7,500
Total heating surface in square feet	40,140	24,050	32,004	27,558	15,947	11,040
Heating surface per I. H. P. natural draught	2.44	2.405	4.0	2.3	2.28	2.2
" " forced "	......	......	2.56	1.62	1.77	1.475
Total grate area in square feet	1439	750	587	940	560	406
Length of firebars	6 ft. 3 in.	6 ft. 3 in.	7 ft. 3 in.	7 ft. 1½ in.	7 ft.	7 ft. 3 in.
I. H. P. per square foot of grate, natural draught	11.47	13.33	13.6	12.78	12.5	12.3
" " " " forced "	......	......	21.3	18.1	16.05	18.4
Total boiler-room area in square feet	4925	3100	2440	3470	2230	1900†
I. H. P. per square foot of boiler-room area, natural draught	3.35	3.22	3.28	3.46	3.14	2.63
I. H. P. per square foot of boiler-room area, forced draught	......	......	5.12	4.9	4.03	3.94
Heating surface per square foot of boiler-room area	8.15	7.77	13.1	7.94	7.16	5.82
Grate area per square foot of boiler-room area	.292	.242	.24	.276	.251	.214
" " " on basis 6 ft. 3 in. bars	.292	.242	.207	.242	.22	.185
Total weight of boilers, uptakes, and funnels, in tons	559	342	217	447	270	174
Total weight of water in boilers, in tons	43	30	30	197	103	82
" pumps, pipes, connections, water in feed tanks, &c., in tons	168	100	82	97	55	41
Total weight in boiler-rooms in tons	770	472	329	741	428	297
Weight in boiler-rooms in pounds per I. H. P. natural draught	104	105.5	92.2	138	157	133
Weight in boiler-rooms in pounds per I. H. P. forced draught	......	......	59	97.4	106.3	89
I. H. P. per ton of boiler-room weight, natural draught	21.4	21.19	24.5	16.2	16.4	16.8
I. H. P. per ton of boiler-room weight, forced draught	......	......	38.0	22.9	21.1	25.2

* Natural draught here implies the usual Admiralty conditions, in which an air pressure of ½ in. of water column is permitted.
† Boiler-rooms very large in this vessel.

GENERAL CONCLUSION.

The comparisons made appear to lead to the following general conclusions in the case of the three types of boiler considered, starting on the basis of equal space occupied.

The Belleville type is well adapted for maintaining high continuous sea speeds for long periods, and is very economical at high powers. It is comparatively light and well arranged for cleaning and overhaul. Steam can be raised quickly, and large variations in power made readily. It cannot, however, be forced, and has also the objection of great complication of detail and accessories, with consequent liability to derangement.

The Yarrow type is hardly so well adapted for continuous steaming at relatively high powers, and is not so economical under such circumstances. It can, how-

ever, be forced to almost any extent with safety, and much higher speeds obtained for considerable periods. Steam can be raised quickly, and large variations in power made readily. It is extremely light, and, being simple in detail, has small liability of derangement. Cleaning and overhaul are fairly easy, but the examination of the outside of the tubes is difficult.

The cylindrical type is about equal to the Yarrow for continuous high-power steaming, though probably slightly less economical. At low powers, however, it is very economical. It can be moderately forced with safety, and is well adapted for ordinary cleaning and overhaul. All its arrangements are extremely simple and unlikely to become deranged. Sea water can be used in it with safety. It is, however, heavy; steam can only be raised very slowly, and large variations in power cannot be made quickly.

The foregoing conclusions, the writer submits, point to the fact that the boiler question is one which must be dealt with in its relation not only to each individual class of ship, but to each individual service. The adoption of any type will depend upon what particular qualities are most desirable for the boilers to possess to meet the special work which the vessel is designed to do. The general naval policy of any Power will thus have a direct bearing upon the question of what type of boiler is preferable for a given ship.

In conclusion it may be added that the three types considered are given merely as a comparison of actual examples of typical boilers, and are not put forward in any spirit of comparison with other types of boiler or other systems of working.

† More recent Yarrow boilers, fitted with Mr. Yarrow's feed heating arrangement, are fully equal to the Belleville type in economy.

Breakdown of S.S. Waikato.

The British steamship *Waikato* from London to New Zealand ports reached Fremantle, West Australia, recently after a voyage of 157 days. When the vessel had been out of port a month the machinery broke down, and though temporarily repaired was finally altogether disabled by the fracture of the tail shaft. As she would not steer her condition was very serious, and she was driven about for 30 days until sighted by a sailing ship. The vessel tried to take the steamer in tow, but as the weather was unfavorable did not succeed, and finally sailed away taking with her the news that the steamer was helpless. As the result of this information a British cruiser was sent out from Mauritius to look for the *Waikato,* but did not succeed in finding her. The *Waikato* was subsequently sighted by several vessels, among which was the *Alice,* of New York, which supplied the disabled steamer with sails and provisions. About the middle of September the steamship *Asloun* came up and took the *Waikato* in tow. The *Asloun* was short of coal and, consequently, with her tow she proceeded to Amsterdam Island where in sheltered water a large quantity of coal was transferred in the ships boats from the *Waikato* to the *Asloun.* Then the voyage was resumed, not without incident, however, for before reaching the Australian ports the tow ropes parted and the vessels lost sight of one another on one occasion. It is greatly to the credit of those on board the disabled vessel that entire harmony prevailed in the trying time adrift.

COMPARISON BETWEEN PERFORMANCES OF TWO SEA-GOING STEAMSHIPS.*—II.

BY J. D. M'ARTHUR, MEMBER.

On account of slight corrosion manifesting itself in the boilers, and being ascribed to air amongst the feed-water, the main internal feed pipes were turned up so as to discharge the water into the steam space, at a considerable height above the water level. It is doubtful, however, whether air was really the cause of the corrosion, for amongst its other good qualities, Weir's heater rids the water pretty effectively of any air it might contain, and moreover, in the case under consideration there was little or no air in association with the water during any part of the cycle.

The boilers of both steamers were very similar in all particulars save one, namely, that those of A had an extra dead-plate about 9 in. long fitted to each furnace and the whole grate shifted back this amount. The result of this was that during two years not a single baffle-plate required renewal or repair of any sort beyond cleaning the perforations, and were as effective in promoting an equal distribution of the air to all parts of the grate as when new. On the other hand, it must be taken into account that the grate being virtually 9 in. longer, that is, the bridge being further from the furnace mouth, rendered good stoking rather more difficult, especially when the coal formed a heavy clinker, as often happens with forced draught. Little difficulty was found, however, in the actual working, even with Lascar firemen.

In the case of B, whose furnace dead-plates were of the ordinary length, the baffle-plates in proximity to the glowing fuel soon burnt out, and the complete set required renewal on an average every nine months. Further, the author is of opinion that this militated to a certain extent against the economical working of these boilers, for when one side plate gave out, as very often happened, the greater body of the air following the path of least resistance would naturally pass to that side of the furnace, and issuing in bulk, as it were, could not mix so intimately or immediately with the products of combustion as when entering in finely divided streams over the whole of the combustive area.

The ratio of heating surface to grate area was practically the same in both ships, being about 52 to 1. The tubes were 2 1-2 in. dia., 8 ft. 9 in. and 8 ft. 4 in. long and fitted with retarders. In A's boilers the grate area (117 sq. ft.) was reduced to 100 sq. ft., by increasing the length of the bridges. In B's, the actual area was about 90 sq. ft., so that in the first case the consumption per square foot of grate per hour averaged 18 lb., and in the second 22 1-4 lbs., the air pressures in each case being, at fan, A, 1 in. to 1 1-4 in.; B, 1 3-4 in. to 2 in.; ashpits, 3-4 in. and 1 3-8 in., and in furnaces, 1-4 in. to 3-8 in. and 3-4 in. to 1 in. respectively. Not being provided with pyrometers it was impossible to find the temperature of furnaces, uptakes, etc., but a comparison of the two funnels suggested an experiment to the author which he thought might be worth a trial. The heights of the funnels were, A, 70 ft., and B, 63 ft. 6 in.; the velocity of the escaping gases would vary

* Read before the Institute of Marine Engineers, London England.

as the square root of the heights in feet, or as 8.37:8; on the other hand, B's funnel, whose diameter was 8 ft. 3 in., had an area of 121 times the area of A's, whose diameter was only 7 ft. 6 in., the total quantity of gases escaping at the same temperature would be proportional to the area and velocity, in other words, the quantity delivered by B would be $\frac{1.21}{1.046} = 1.16$ times that escaping from A, neglecting entirely the greatly increased air pressure in the furnaces, which would still further augment the disproportion; the fuel burnt in B's furnaces being only 1.13 times A's consumption. The suggestion intended was, that had a damper been fitted in the funnel, it might have been possible to find one particular area which would give the best result by checking the apparently too great flow of gases, to aid more perfect combustion and bring them more intimately into contact with the heating surfaces by imposing, as it were, a slight pressure in combustion chambers and tubes.

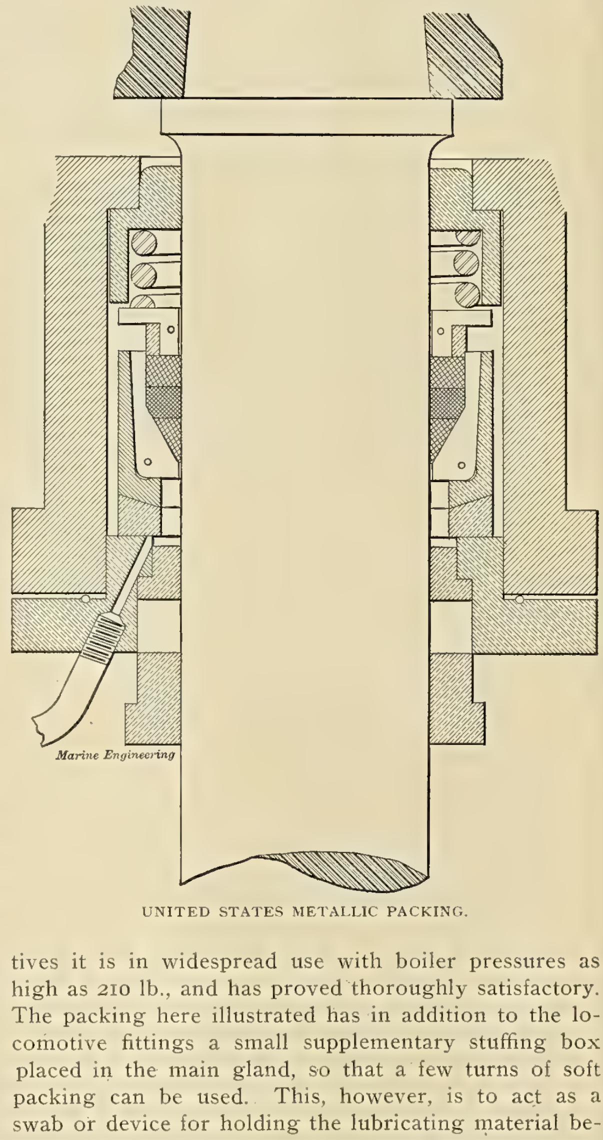
In B's engine-room and stokehold it must be admitted that the bad points outweighed the good ones, or at least, as happens very often when other things than machinery are under notice, they occupied the most prominent position. Dirt in an engine-room is to be avoided as far as possible, not only so from appearance sake as on account of its pernicious effect on all wearing surfaces. Anyone who has been at sea with boilers working under Howden's forced draught must know how extremely difficult it is to prevent dust from getting into the engine-room, particularly when there is only a thin screen bulkhead between the boiler backs and the engine-room, as is the usual mode of construction; and the reason is not far to seek, either, for while with natural draught the direction of the air-currents is in towards the ash-pits, with forced draught the ash-pits are closed, and the fan, being in most cases situated in the engine-room, causes an in-draught of air through skylights, ventilators and crevices in bulkheads, the latter being often effectually aided by the stokehold ventilators trimmed to the wind. There was no tank below the boilers or engines in the arrangement of B, and the screen-bulkhead extended no lower than the engine-room platform, leaving a free inroad for coal dust, ashes and hot vapor from clearing fires, while to make matters worse, the only means of egress above the boilers was through two small mushroom vents. This had also the effect of rendering both engine-room and stokehold almost unbearably hot—a temperature of 140 deg. in the engine-room and 145 deg. to 150 deg. in the stokehold being not uncommon east of the Suez Canal—a factor very much against the human element concerned in the economical working of boilers, and especially careful stoking, which is doubly important in boilers with forced draught, for, if the bars be not evenly covered to a uniform depth in all the furnaces, the thinnest fires, or parts of the fires, will burn through first, and offer a freer passage to the air under pressure in the ash-pits, thereby retarding the combustion of the thicker parts of the fuel, and eventually lowering the temperature of the furnace or furnaces by admitting a quantity of uncombined air to cool down the products of combustion.

(*To be continued.*)

IMPROVED APPARATUS.

Torpedo Boat Engine Packing.

Our engraving shows a special design of metallic packing made for two of the torpedo boats now building for the U. S. Navy, in which the initial pressure is 250 lb. per sq. in. This packing is an adaptation of the standard "United States" metallic locomotive packing to marine work. In the form adopted for locomotives it is in widespread use with boiler pressures as high as 210 lb., and has proved thoroughly satisfactory. The packing here illustrated has in addition to the locomotive fittings a small supplementary stuffing box placed in the main gland, so that a few turns of soft packing can be used. This, however, is to act as a swab or device for holding the lubricating material between the stuffing box and the main packing, rather than a preventive of the leakage of steam. The main packing takes care of the latter, though the only metal parts allowed to come into contact with the rod are the special composition rings. It will be noticed that the vibrating cup, which is the part holding the rings, is of unusual construction, so as to permit of the packing being applied to a rod with shoulders at the piston and cross head ends, such as used in a torpedo boat engine. The outside end of the vibrating cup is solid and made of steel, and the smallest internal diameter is large enough to fit over the shoulders of the piston rod. Inside of the cup two half pieces are fitted

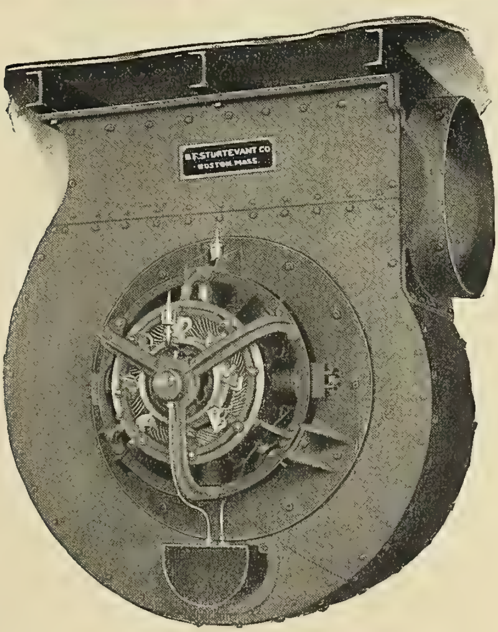


UNITED STATES METALLIC PACKING.

and within these are the metal packing rings. The connection is shown in the drawing for a forced feed lubricating device, and by an arrangement of small valves in the connecting pipes this orifice can be used as a drain to pass off any accumulation of water of condensation. In an emergency fibrous packing can be used in the vibrating cups instead of the metal rings, though, of course, this would not be efficient for continuous service. Various forms of marine engine packing are manufactured by the patentees, some of which are specially useful where the clearance spaces are small and the stuffing boxes shallow; a difficulty frequently met where it is desired to substitute metallic for fibrous packing. The manufacturers are the United States Metallic Packing Co., 427 North Thirteenth street, Philadelphia, Pa.

Suspended Electric Fan.

One of the prime advantages of an electric fan is its adjustability. Not only may it be located where most convenient for the adjusting of piping, but it may readily be constructed in such form as to be supported or suspended as may best suit the conditions. The accompanying illustration serves to make clear this point, for it represents an entirely new design built upon a special order by the F. F. Sturtevant Co., of Boston, Mass. The fan as here shown was designed for use on shipboard, and is suspended from the deck. In general form the fan itself is of the usual steel plate construction, being an exhauster with the inlet on the side farthest from the motor. The motor itself is of entirely special construction, having eight poles, rendering it very compact, so that it extends the minimum distance from the side of the fan. In the size here shown, the field ring was of wrought iron, although



STURTEVANT SUSPENDED ELECTRIC FAN.

in larger sizes it is built of cast steel or cast iron. The cast iron plate with projecting lugs which is attached to the fan side serves to center and hold in position the field ring of the motor, while tripod hangers extending from either side of this ring support the armature shaft in ring oiler boxes. The field cores are of wrought iron, giving the highest efficiency to the field, and the pole shoes are of cast iron of such peculiar shape and size as to render the machine capable of extreme variation of load without sparking at the brushes, and without any shifting or adjustment whatever. The field coils are machine wound, and thoroughly insulated, their form being thoroughly open. The windings present a maximum amount of radiating surface, which results in the most perfect ventilation, and prohibits any great amount of heat. The armature cores are built up of laminated, slotted discs mounted on a cast iron spider, having a hub projection for the reception of the commutator. These core discs are solidly clamped between two brass rings which have corresponding core teeth. The armature is of the core wound drum type, and in the usual form has a two-circuit winding, although in some cases multiple winding is used. This type of winding on machines of low speed and small output is of great advantage. The commutator is of large diameter, and consists of pure rolled or drop forged copper segments supported in a cast iron shell of spider construction, and thoroughly insulated. Reaction brushes of fiber graphite are used, and supported by special rigging. These motors require no shifting of brushes from no load to full load, thereby greatly reducing the attention required. Fans of this type can be constructed in various sizes and forms, and motors can be provided having capacities ranging from three to 125 horse power.

Loss of S. S. Ariosto.

A sad and apparently needless loss of life resulted from the stranding of the British steamer *Ariosto*, which went ashore about six miles south of the Hatteras life saving station on the Atlantic coast, December 24. The *Ariosto* was a vessel of 2,265 tons and was bound from Galveston to Hamburg via Norfolk, laden with cottonseed products and grain. She lost her bearings in the fog and was blown ashore by a heavy gale. After the vessel stranded the crew sent up rockets and at daylight attempted to get away in the boats. Three boats left the ship, but were swamped and all occupants were drowned in sight of the life saving crews from the Hatteras and Ocracoke stations, which had come down to the beach. The captain and eight of the crew remained on board of the vessel, and after several attempts the life savers succeeded in reaching them with a line fired from the Lyle gun. When connection with the vessel was secured the breeches buoy was sent out and those on board were brought ashore in safety. The number drowned exceed twenty.

S. S. Paris.—It has been decided to thoroughly repair the S. S. *Paris* and put her back on the New York-Southampton route of the American Line. The contract for the work has been made with Harland and Wolff, of Belfast, Ireland, who have had considerable experience in this class of work. The most notable case, perhaps, in which they repaired a seriously damaged vessel was that of the P. & O. liner *China*. It is probable that new machinery will be fitted in the *Paris* while the repairs to the hull are going on. The vessel will be renamed for an American city when she goes into service again.

MARINE ENGINEERING

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SECRETARY OF THE NAVY John D. Long, in his annual report recommends the consolidation of the present separate naval bureaus of Construction and Repair, Steam Engineering, and Equipment under one head—the Bureau of Ships. The Secretary is careful to state that the change is recommended on systematic and not on personal grounds, though to those familiar with the present conduct of the bureaus such an explanation would not be necessary. The terms of office of the present chiefs of the three bureaus will expire in little more than a year, and it is suggested that the change be not carried into effect until that time. At first sight this proposal seems very radical, but after consideration it appears to be a natural sequence to the enactment of the Personnel Bill. That bill practically abolished the Engineer Corps, and left, therefore, the Construction Corps as the only titular engineer (mechanical) corps of the Navy. It has been the contention of representatives of the former Engineer Corps that the bill practically operated to expand the Engineer Corps, so as to take in all line officers, rather than to permit the deglutition of the engineers by the line. This last seems to be recognized by the executive heads of the Navy, for, we are informed, since the passage of the Personnel Bill assignments have been made of former engineer officers to line duty, but none of line officers to exclusively engineer duty. The broad statement that in the future every naval officer afloat must be an engineer has been iterated and reiterated. This, we believe, is so to a limited extent so far as operation is concerned. Construction is another matter altogether. Returning again directly to the proposal of the Secretary of the Navy; of the three bureaus named, those of Engineering and Equipment are now controlled by line officers, while the Bureau of Construction is distinctively an engineering bureau with functions of a technical character, and its membership wholly removed from any participation in combatant duties or responsibilities. In the natural order of things it would mean, therefore, that consolidation of the bureaus would result in the ultimate direction of affairs by members of the Construction Corps. Among the present members of this corps are several who have been trained as naval engineers and have this knowledge in addition to their attainments as naval constructors. This would not probably be the immediate result, for, of course, there are now in the ranks of the combatant officers many highly skilled and experienced men who formed the late Engineer Corps, and whose services will undoubtedly be continued along the lines of their training. But as these officers are retired and the present and prospective cadets come to fill their places, in the combatant ranks, the latter will not be nearly so well qualified for the work of construction as the members of the highly specialized Construction Corps. There is another department, however, which we believe the Secretary might have included in his consolidation scheme with advantage to the Navy, and that is the Ordnance Bureau. This is just as much an engineering bureau and, rightly, just as little a combatant officers' bureau as the department of steam engineering under the old order of things ever was. There is very little in the construction of modern guns and armor that calls for high qualifications as drill master or navigator on the part of any one engaged in such work. A gunmaker is a mechanical engineer just as much as a builder of steam engines, no matter what he may be officially styled. The Secretary of the Navy says that when a contract for the construction of a ship is made it is made with one builder, and not given part to a ship constructor, part to an engine builder and part to an outfitting firm. Quite true, so far as it goes, but it is also true

that the most modern development of the warship building business is for one concern to build, arm and equip the vessel; so that all she needs is to take on coal, ammunition, stores and crew, and go out complete to give battle. The most notable example in the shipbuilding world is the Armstrong-Whitworth combination, and there is also the Vickers consolidation, and still later the arrangement between John Brown & Co. and the Clydebank yard as to armor. With such combinations it is reasonably within the possibilities to get the "adaptation and harmony of movement" suggested, and that convergence of effort toward the apex of perfection which is not possible by any system of parallel authority.

A NOTE of alarm is sounded by Engineer-in-Chief George W. Melville, U. S. N., in his report for 1899 concerning the results which the Personnel Bill, in actual operation, will produce. The interpretation of a law by persons entrusted with its enforcement is not always in accordance with the views or intentions of those who created it. Much depends upon the view-point of the individual, the character of his training and environment. It was apparently the intention of the Engineer-in-Chief and his advisers that on the bill taking effect the "whole trend of detail would be toward the complete amalgamation of line and engineering interests in the navy with the most favorable outlook for the protection of the rapidly advancing engineering science." Considering that the enactment of the bill was the result, chiefly, of an agitation commenced by the engineers, and that the compromise which produced the bill was the consolidation of the numerically small engineer corps with the numerically large line, it might reasonably be supposed that the former line, pure and simple, would be the controlling influence. This is a country of majority rule and, so far as matters have gone, the tendency seems all in the direction of the establishment of slightly enlarged line duties for all naval officers afloat, and the relegation of the exclusively engineering functions to enlisted men—the warrant machinists. No doubt the line officer would be quite willing to exercise such supervision in the machinery spaces as he now gives in the dynamo room. We believe that this is all that could in reason be expected of him. The ideal naval officer is of a different habit of body and mind from the scientific engineer; and life below, amid semi-darkness, heat, dirt, disagreeable smells, and the like, is little to the fancy of the genuine seaman—no more in the navy than in the merchant marine. A continuance of this policy would, therefore, place the real burden of responsibility upon the shoulders of the warrant machinist without giving him, under present regulations, any of the rights or privileges of the commissioned officer. How long any self-respecting body of men, such as would be qualified to take responsible—not nominal or official—charge in the engine room of one of our battleships or cruisers would tolerate this anomalous condition is something we would not care to predict. That the Engineer-in-Chief recognizes the human nature of the case is shown by this statement in his report:

> I feel it necessary to draw your attention to the necessity of governing the duties of this new grade of mechanics in such a way as will secure to the service their continued skillful assistance as direct operators and repairers of machinery. With the official elevation which comes with a warrant there is not unreasonable apprehension that these men will desire a severance from actual manual care of the machinery of our ships, and will expect to act merely as engineering supervisors below. This, of course, would be wholly inconsistent with the interests of the service, as at no previous time in naval history has there been a greater demand for the highest mechanical skill in the persons of those who have direct charge of marine motive power. Clear and definite regulations are needed on this point at the start, in order that no ambiguity may foster discontent with simple duty or lead to hopes of further official elevation. The engineer officer is and must be the line officer of the future; the warrant machinist must recognize the necessity of his expert mechanical work as well as the distinction he is given by reason of his excellence in it.

If the warrant machinist in the future finds that he is carrying on the work, afloat, which in times past was the duty of the commissioned engineer officer it is difficult to see how he can be, fairly, prevented from demanding a more dignified position among the personnel than that of an enlisted man. His qualifications should certainly be not less than those possessed by the volunteer engineers who at the close of the Civil War were transferred to the commissioned ranks of the naval corps of engineers. It should not be forgotten that it was distinctions of rank, more than anything else, that caused dissatisfaction among the members of the late Engineer Corps and led to the enactment of the Personnel Bill. History repeats itself.

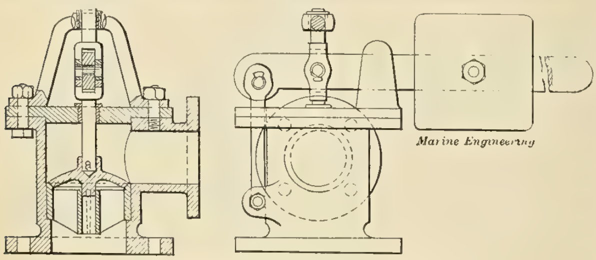
HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—III.

BY DR. WILLIAM FREDERICK DURAND.

§ 2. MATERIALS AND CONSTRUCTION.

[5] Boiler Mountings.

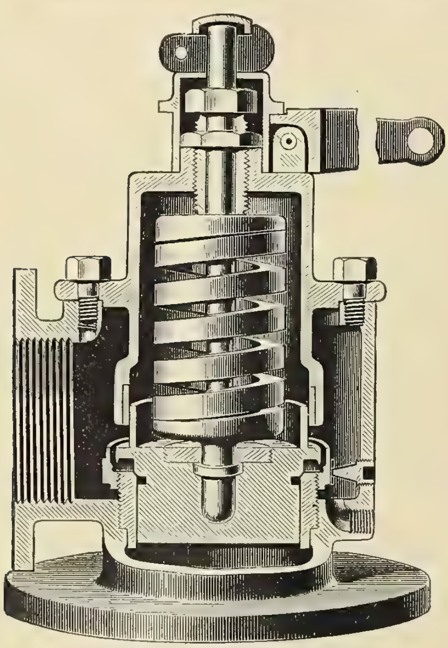
Safety Valves.—The purpose of the safety valve is to provide for the escape of the steam in case the pressure should tend to rise above the safe working limit for which the valve is set. There are two kinds of safety



U. S, STANDARD SAFETY VALVE.—Fig. 1.

valves, known as *lever* and *spring* valves, according as the valve is kept down on its seat by a weight on a lever or by a powerful spring under compression. Fig. 1 shows the construction of the standard U. S. lever valve.

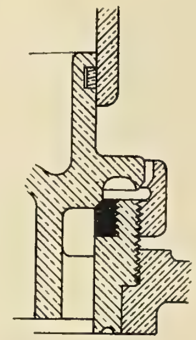
The valve itself has a plain conical face, and fits to a corresponding seat as shown. In its motion up and down it is guided by the double stem, so that it can by no means become jammed in the chamber. The pressure of the steam comes on the bottom of the valve, and as it reaches or passes the limit for which the adjustment is made the valve lifts and the steam escapes about the edge, and thence is led by the escape pipe to the deck. The actual lift of a safety valve is very small,



SPRING SAFETY VALVE.—Fig. 2.

1-8 in. being usually a large lift. The opening for the escape of the steam depends, therefore, on the circumference of the valve and on the lift, rather than on the area and lift. Safety valves are, however, usually designated and determined according to their area. The weight acts by means of the lever, as shown, and may be adjusted so as to allow the valve to open at the pressure desired.

In modern practice the lever valve is infrequently used, except in vessels engaged in smooth water (river) service, the spring valve being fitted almost universally. In this form of valve, which is shown in Fig. 2, the chief point of difference is in the substitution of the spring for the weight and lever. The tension of the spring is adjusted by a screw at the top, so that the valve will not open until the limiting pressure is reached or exceeded. It is readily seen that as soon as the valve rises the spring is compressed and the tension is increased. It is also found that with the plain form of valve, as shown in Fig. 1, the pressure on the face decreases the instant the valve lifts. Due to these facts it follows that such a valve, especially when controlled by a spring, is apt to seat itself the instant after rising, lifting again the next instant in answer to the restored value of the



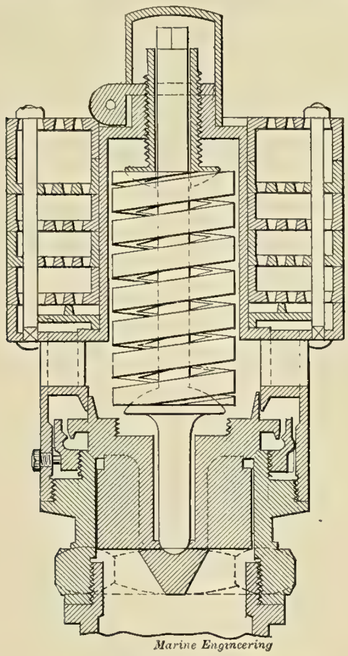
ENLARGED SECTION OF LIP.—Fig. 3.

pressure. This irregular action will lead to a rapid opening and closing of the valve, producing a chattering noise very undesirable in passenger boats, and interfering with the continuous and regular escape of the steam. To avoid this a lip of one form or another, as shown in Figs. 2, 3, and 4, is fitted to the valve at or beyond the edge, so that it may catch the escaping jet of steam, and thus increase the effective area of the valve after it has lifted from the seat. In such case the valve is forced farther from the seat, and while it still vibrates, it remains definitely open until the pressure has fallen some 4 or 5 lb. below that for which it opens. The valve then touches the seat in one of its vibrations downward, and remains closed until the pressure again rises to the point for which it is set. The safety valve should always be fitted with a hand lifting gear, so that it may be opened by hand when desired, and the spring adjustment should be protected by lock and key, so that it cannot be changed by unauthorized persons.

For large boilers, instead of one large valve safety valves are often fitted in groups of two or three. This reduces to the smallest possible limit the danger from sticking or other derangement of the valve. The safety valve or valves should always be attached to a fitting leading direct to the boiler, and with no possibility of closing it off by a stop valve. If both stop and safety valves are attached to the same fitting the latter must

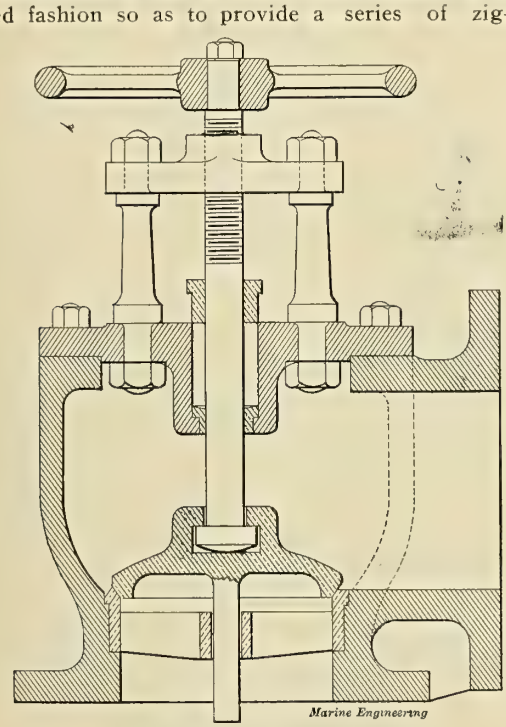
always be placed inside or nearer the boiler than the former.

Muffler.—This fitting, though not in the fire-room, may be properly referred to at this point. It consists of a metal chamber filled with bits of metal or stone, mar-



SAFETY VALVE AND MUFFLER.—FIG. 4

bles, wire-gauze, small spiral springs, or with thin plates in layers pierced full of holes and arranged in staggered fashion so as to provide a series of zig-zag

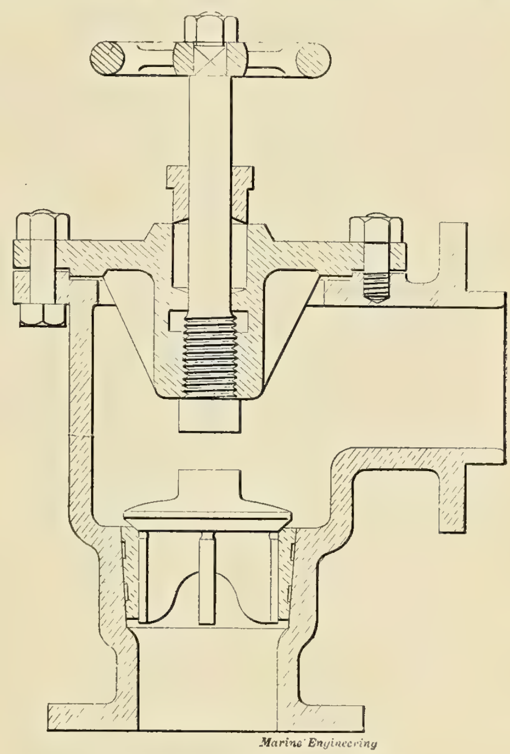


BOILER MAIN STOP VALVE.—FIG. 5.

passages for the steam. The steam from the safety valves and escape pipe makes its way to the air through this chamber, the purpose of the filling being to muffle or deaden the noise, which might otherwise seriously interfere with the giving of orders on deck. Fig. 4 shows a combined safety valve and muffler, the latter with plates as above described. Such an arrangement would be applicable for small or open craft having but one boiler, such as launches, small yachts, etc.

Stop Valve.—Each boiler is connected through a separate boiler steam pipe to the main pipe. The entrance of steam to this pipe is controlled by the boiler stop valve, which thus provides for the regulation of the supply of steam to the engine, and for closing the boiler off entirely from the main steam pipe if necessary. The usual type of valve employed is shown in Fig. 5, and consists of a valve disc guided to its seat by wings, and raised or lowered by its connection with the screw spindle and handle as shown.

Commonly in warship practice, and to some extent in mercantile practice, such valves are made self-closing in case of rupture of the boiler. In fundamental principle such a valve is a form of *non-return* valve, as illus-

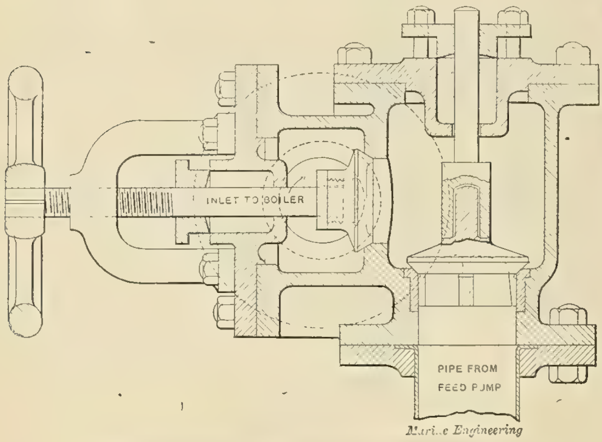


BOILER CHECK VALVE.—FIG. 6.

trated by the check valve of Fig. 6. The screw stem does not open the valve, but limits simply the extent to which the valve can open. A second plain stem passing through the first then allows of the valve being pulled open by hand, even if there is no definite difference of pressure to force it open. In case of accident which reduces the pressure back of the valve so that the rush of steam is in the reverse direction to its usual flow, the valve will be closed by this rush and held securely on its seat by the excess of pressure on its outer face, thus shutting off the injured boiler, and retaining the others intact for use. If such an arrangement is not fitted and the valve cannot be closed by hand, or until it can be thus closed, an entire battery of boilers may be thrown out of use by the rupture of any one of them, all of the

steam formed escaping through the one opening. Such form of valve should be placed with the spindle horizontal, so that its own weight may not enter as a direct factor in the movement of the valve toward and from its seat.

In warships, where the pipes or boilers may be pierced



COMBINED CHECK AND STOP VALVE.—FIG. 7.

by the fragments of exploding shell, such a safety provision may be of the utmost importance and value.

Dry-Pipe, or Internal Steam Pipe.—This is a pipe of relatively thin metal placed within the boiler, extending lengthwise, and close to the top of the shell. At the inner end it is closed, and at the outer end connects with the pipe leading to the safety valve chamber, stop-valve and boiler steam pipe. Along the top of the pipe are cut a large number of narrow slits, through which the steam enters the pipe. This arrangement has the effect of drawing the steam from the highest part of the steam space, and of straining out some part of the entrained water. A small hole in the bottom of the pipe provides for draining off the water which may gradually collect.

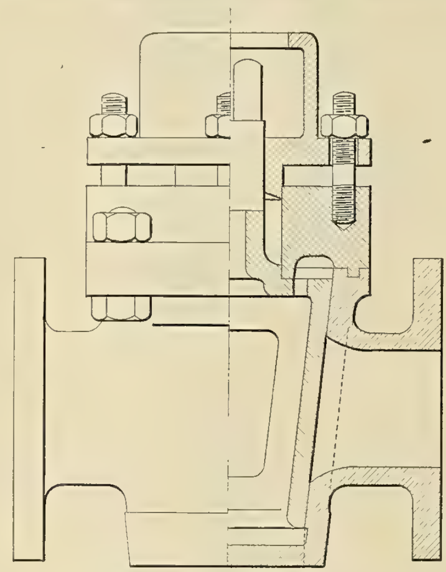
The uniform draft of steam from the whole length of the boiler tends also to prevent the priming which might be caused by drawing it all from one point.

Feed Check Valve and Internal Feed Pipe.—The water from the feed pump comes to the boiler through the feed pipe, and then at the boiler passes through the feed-check. This is a screw-down, non-return valve, as shown in Fig. 6. The valve itself is entirely disconnected from the spindle, and the latter simply limits the height to which the valve can rise, while by screwing down sufficiently the valve may be forced shut and held there. This construction is adopted so that should the feed pump stop working or between the strokes of the pump there may be no escape of water backward from the boiler into the pipe. Two such check valves are usually fitted to each boiler, one connecting with the main and the other with the auxiliary feed pumps.

In modern practice a stop valve is usually fitted between the check valve and boiler, in order that, if necessary for examination or repair, the check may be shut off from communication with the boiler. Such combined stop and check valves are frequently fitted in a single casing, the stop valve, of course, being placed next the boiler (see Fig. 7.)

After passing through the check-valve the water enters the internal feed pipe, by which it is led to the point or points of delivery. The end of the pipe is usually closed, and the water is delivered through a large number of small holes distributed along the pipe. The delivery is usually below the water level, and often between the nests of tubes where it meets with the rising currents of water heated by them. In some cases it is led to the bottom of the boiler, where it mixes with the relatively cool water there found; but this plan cannot be recommended, as it retards rather than assists circulation. In some cases also the water has been introduced as a spray into the steam space, but, while this plan has some advantages, it has not met with general favor.

In water tube boilers the feed water is usually fed into the upper drum, whence it joins the circulation in


BOTTOM BLOW-OFF VALVE.—FIG. 8.

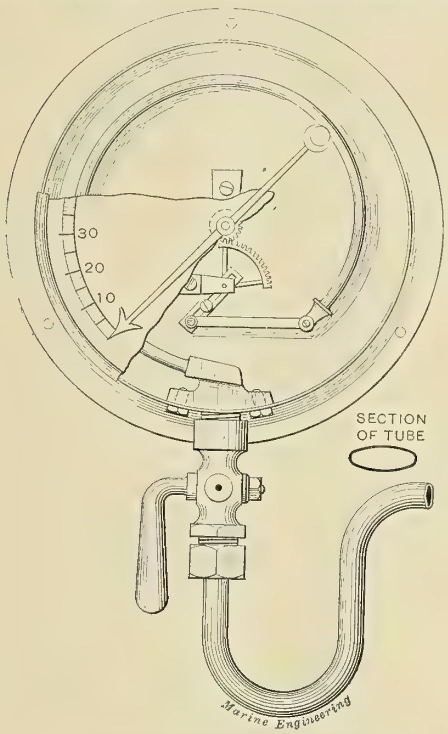
the boiler as noted in the description of boilers of this type.

Surface and Bottom Blows.—Cocks or valves and connecting pipes are fitted for blowing grease and scum, or mud sediment and water, out of the boiler into the sea—Fig. 8. The surface blow is a valve which is attached an internal pipe lying just below the normal water level, and either perforated with holes or leading to a shallow open pan. Outside the boiler there is a discharge pipe leading to an outboard valve, through which the discharge is effected. The scum and grease which collect on the surface of the water may by means of this arrangement be blown out of the boiler, and thus disposed of. In early engineering practice the bottom blow was of great importance, as it was used not only to discharge mud and sediment, but also the relatively dense water in the boiler when blowing down to reduce concentration, or when emptying the boiler of water for purposes of examination or cleaning. In modern practice with the surface condenser and the evaporator, blowing off to reduce concentration is no longer necessary, and blowing the water out of a boiler with its own steam is no longer considered good practice. The preferable plan is to allow the steam to condense and the water to cool down, and to then run it into the bilge or remove it by pump connections suitably arranged. Due

to these facts, bottom blow valves have been sometimes omitted. There may still, however, be occasion to use such valves for the discharge of mud and sediment, and therefore, they are still quite generally fitted. In any event, there should be some valve and pipe connected with the lowest part of the boiler, and through which it can be emptied in one way or another.

Both surface and bottom blows are usually fitted to water-tube boilers, especially to those types consisting of upper and lower drums with sets of connecting tubes. The surface blow is for scum and grease, while the bottom blow is essentially for mud and sediment, and is often attached to a special *mud-drum* provided to collect such substances.

Steam Gauges.—The steam pressure within the boiler, or rather the excess of the pressure within over the atmospheric pressure without, is shown by some form of steam gauge, of which the best-known and most used are those employing a *Bourdon tube.* In Fig. 9 is shown



BOURDON STEAM GAUGE.—FIG. 9.

such a gauge and tube, the cross section of the latter being an ellipse as shown. When the inside of the tube is subjected to the pressure of the steam it tends to become round in section, and as a result of this the tube as a whole tends to straighten out. This carries the free end outword, and this movement, by means of suitable connections, is made to give motion to the needle. These gauges are graduated by comparison with a mercury column or other form of gauge tester, or with a standard gauge which has been thus graduated. Steam should not be allowed to enter these gauges, as the change in temperature may affect the accuracy of the reading. To prevent this the pipe leading to the gauge is always provided with a loop or U bend, called a "goose neck," which serves as a trap for the water condensed beyond this point. In this way the Bourdon tube and part of the connecting pipe are kept filled with water, which in turn is acted on by the steam, and thus the pressure is indicated without the actual presence of steam within the gauge. Steam gauges require comparison with a standard gauge from time to time, in order to make sure that their indications are correct. They are often provided in duplicate, and frequently one gauge, at least, is provided of sufficient range to allow of use in the hydrostatic boiler test.

Water Gauge and Cocks.—The level of the water within the boiler is shown by a vertical glass tube connected to fittings at each end, which in turn connect the one with the steam space and the other with the water space. As shown in Fig. 10, the entire arrangement of glass and fittings is attached to a hollow mounting called the *stand-pipe, water-column,* or *water-gauge mounting.* To the top and bottom of this are attached pipes, one leading to the steam space at or near the top, and the other to the water space at or near the bottom. In connecting the pipe with the steam space care must be taken that the opening is not near a steam outlet, as the rush of steam past such an opening might disturb the pressure and render the indications inaccurate by showing a higher level of water in the glass than actually exists in the boiler. At the bottom of the mounting a drain cock and pipe are provided, so that the glass may be blown through and cleaned as occasion requires. Screw plugs are also fitted above and below in a line with the base of the tube, so that if necessary a wire and swab may be run through the glass. Instead of the connections as shown in Fig. 10, and which are to be considered as preferable, the ends of the water column are sometimes connected by horizontal passages directly to the boiler, as in Fig. 11, which shows the fitting attached to the curved shell of boiler. With such a mounting the level of water in the glass is more liable to fluctuation and disturbance due to rolling of the ship or to priming than with the arrangement of Fig. 10.

Gauge glasses are usually from 12 to 15 in. in length, and 5-8 or 3-4 in. dia. Due to the fluctuations in temperature and the accompanying expansion and contrac-

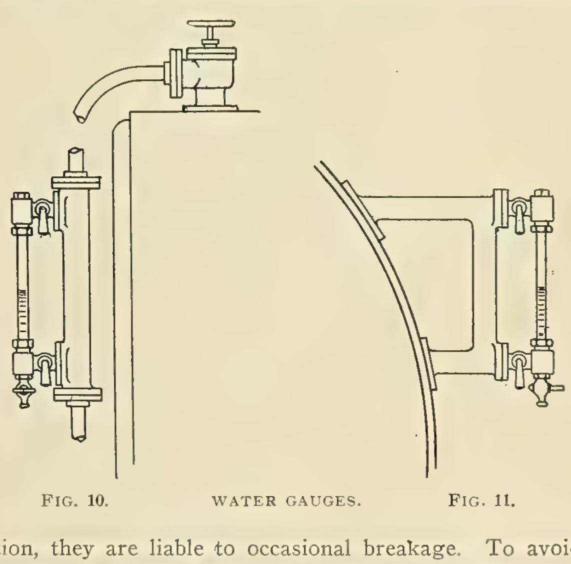


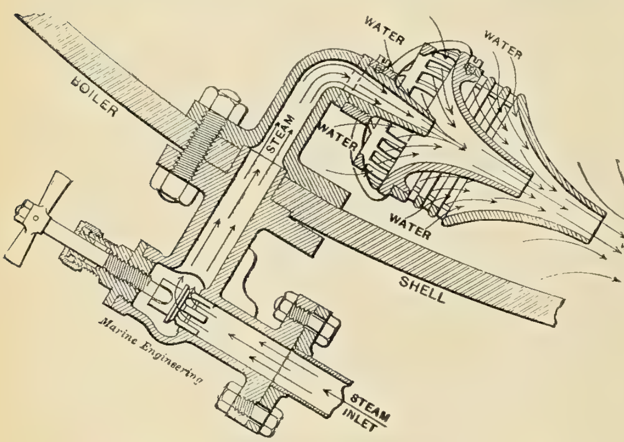
FIG. 10. WATER GAUGES. FIG. 11.

tion, they are liable to occasional breakage. To avoid danger or trouble from the escaping jet of water and steam, it is quite customary in modern practice to fit the connection carrying the ends of the glass with ball non-return valves, working on a similar principle with

the safety stop valve described above. So long as the glass is in place and the pressure equalized, the balls by their weight remain away from the seat and leave the passages open. Upon the breakage of the glass, however, they are carried by the rush of water and steam, each against its seat, thus closing the openings and stopping the escaping jets of water and steam.

In addition to the gauge glass, small cocks, three or four in number, are usually provided. In some cases such cocks are attached to the mounting, and in other cases to the boiler itself. These cocks serve as a check on the gauge glass, or for use in case the glass is not to be depended upon. The glass is usually so adjusted that when the water is at the bottom it is still some 3 or 4 in. above the level of the highest heating surface. The water cocks cover about the same vertical distance, though in some cases the lowest cock is placed nearly on a level with the top of the heating surface. On single-end boilers two such water gauges are often fitted, one on either side at the front, and with water cocks at the back. Similarly on double-end boilers three would be fitted, two on one end and one on the other.

Hydrokineter.—This is an appliance used to force the circulation of the water in the boiler, more especially



HYDROKINETER.—FIG. 12.

when raising steam. It consists, as shown in Fig. 12, of a steam jet and series of nozzles with frame perforated at the back for the entrance of water. The steam is furnished from another boiler, and by its inducing action a current of water is set up and driven along, as shown by the arrows. This arrangement is placed near the bottom of the boiler, and thus serves to drive out the cold water which tends to collect there, and which is only slowly heated by the operation of natural circulation.

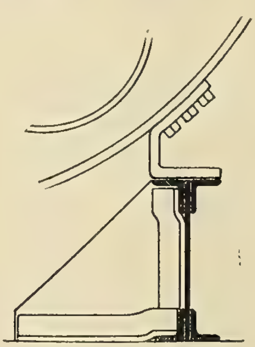
Hydrometer.—The density of the water in the boiler is determined by an instrument known as the *hydrometer*, and shown in Fig. 13. It may be of either glass or metal, and consists essentially of two bulbs with stem as shown. The upper and larger bulb is filled with air, and serves to give buoyancy to the instrument; while the lower and smaller bulb is weighted and keeps it in the upright position. When a body floats freely, wholly or partly immersed in a liquid, the weight of the body equals the weight of the liquid displaced. Hence, in this case the denser the water the less the volume displaced, and the higher the stem out of water. Average sea water contains about 1 part in 32 of solid matter, and hydrometers are usually graduated relative to this as a unit. That is, 2 means twice as much solid matter relatively as sea water; 3, three times as much, etc., while 0, of course, means fresh water. The density of water depends, furthermore, on its temperature, so that the scale on the hydrometer can only be used with the temperature for which it was graduated. This is usually 200 deg. F., though frequently three scales are provided; for 190 deg., 200 deg. and 210 deg., respectively. The water is drawn from the boiler through an appro-

HYDROMETER.—FIG. 13.

priate pipe and connections into a deep, slender vessel the hydrometer scales, and thus its density is observed.

Boiler Saddles.—The weight of the boiler is supported on *saddles*, or *bearers*, which in turn are attached to the structure of the ship. A modern form of boiler saddle is shown in Fig. 14, and consists of two or more supports on each side of the boiler of the form shown, and extending each one for some little distance longitudinally. An older form consists of a plate on edge connected with the structure of the ship, extending transversely under the boiler, and cut out to fit the round of the shell. The upper edge of this plate is fitted with angle irons on one or both sides to give a broader surface of support for the boiler. The form of saddle shown in Fig. 14 gives a better longitudinal support, and, moreover, makes access and examination of the bottom of the boiler more easy than with the other form. Single-end boilers usually have two such saddles on each side, while double-end boilers are given three or four.

In addition, the boiler is held in place in its saddles by stays adjustable by screw turnbuckles, or by other like called a *salinometer pot.* Soon after drawing, the water cools down through the temperature corresponding to



BOILER SADDLE.—FIG. 14.

means. A knee-piece, or chock, is also often riveted to the structure of the ship, projecting just above the end of the boiler at the bottom, and thus preventing endwise motion.

Boiler Lagging.—To prevent loss of heat by radiation the boiler is covered with non-conducting, non-combustible felting, which in turn is held on by iron straps, or in some cases by a complete covering of sheet metal. This covering is known as *boiler lagging.*

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS—X.

BY PROF. C. W. MAC CORD.

All that precedes has reference to the making of drawings (or sketches, as the case may be), in which each view represents only one face of an object, as seen from any given direction. One such view can at best give positive information in relation to two dimensions only: as height and length, if it be a front view; height and breadth, if it be a side view; or length and breadth if it be a top (or "plan") view. In order to give the necessary information as to all three dimensions by means of such drawings, therefore, as we have seen, in many if not most cases three views are required, and not infrequently more than that. And for the general purposes of working drawings, either of details or assembled machines, the methods of construction heretofore explained are admitted, we believe, by general consent to be the best. Nevertheless, there are cases

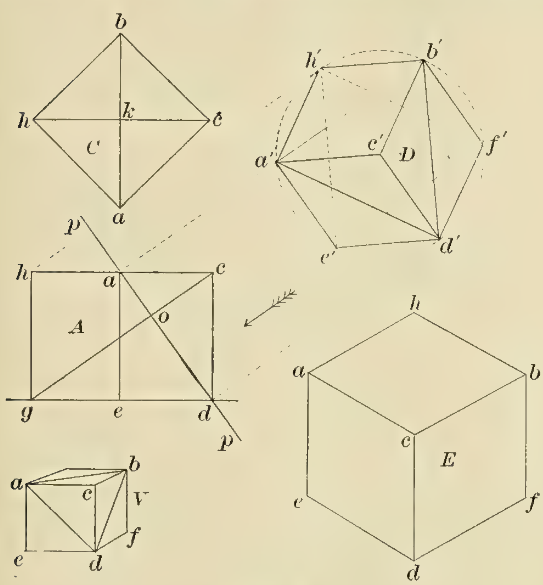


FIG. 43.

in which some method of giving in one view an accurate idea of the three dimensions is very desirable.

A true perspective drawing does not meet the requirement; for, to say nothing of the extreme difficulty of construction, it is impossible to make definite measurements from it, no matter how clear an impression it may give of the general proportions and arrangement. Pictorially, however, it has no equal, since all visible parts are shown in proper relative positions, in true relative proportions, and without distortion; in short, just as they would appear to the eye from the point of view selected.

There are, however, more methods than one of exhibiting the three dimensions in one view, and thus producing an effect of solidity and relief which is lacking in the "working drawings" thus far considered, without incurring the labor of making a true perspective; at the expense, it must be admitted, of a greater or less amount of distortion of one kind or another. Still, these methods are at times very useful; more particularly in making sketches from which working drawings are subsequently to be made in the ordinary way.

The first of these will be understood by the aid of Fig. 43; in which A is a front view of a cube, so placed that, as seen in the top view C, the diagonals ab, ch, of its upper face are respectively perpendicular and parallel to the paper. Now let this cube be cut by a plane pp, passing through the three points a, b, and d; this plane will contain the three face diagonals ab, ad, and bd, as seen in the small perspective view V, and since in the front view ab is perpendicular to the paper, the plane will there be seen edgewise. Moreover, it can be shown that this plane is perpendicular to the body diagonal cg, which is itself parallel to the paper; for, in the top view we have $ke : ca :: ca : ab$; and again,

Kc of the top view $= ac$ of the front view,
ac " " " " $= cd$ " " " "
ab " " " " $= dg$ " " " " ;

whence, in the front view, $ac : cd :: cd : dg$, consequently the triangles acd, cdg, are similar; but also ac is perpendicular to cd, and cd is perpendicular to dg, and it follows that ad is perpendicular to cg.

Now the view D is an *orthographic projection*, being a view of the cube as seen looking perpendicularly against the plane pp, as shown by the arrow. In this view the three face diagonals above mentioned will appear of their true lengths as $a'b'$, $a'd'$, $b'd'$, because they lie in the plane pp; the three edges, ca, cb, cd, are equal in space and equally inclined to the plane pp, hence they will in the view D be equally foreshortened and appear of equal lengths, and the point c will appear as c', the centre of the triangle $a'b'd'$. In a similar manner it may be shown that the points e, f, and h will appear as the vertices of the equilateral triangle e' f' h', whose centre coincides with c', which is also the projection of g. Since then all the edges of the cube appear of equal lengths, this has received the appropriate name of an *isometric projection*. It is sometimes miscalled *isometric perspective*, and also erroneously described as an *oblique projection:* whereas, as above shown, it is in fact simply an orthographic projection upon a peculiarly placed plane.

The lines $c'a'$, $c'b'$, $c'd'$ are called the *isometric axes;* the planes which they determine, and all planes parallel to them, are called *isometric planes;* and all lines parallel to the axes are called *isometric lines.*

In Fig. 43, the actual length of the edge of the cube is cd, while its projection $c'd'$ is equal to od. Therefore, by taking od as a unit instead of cd, an *isometric scale* might be constructed, by which the lines of the projection might have been set off, or by which the isometric lines in such a projection might be measured. Were such a proceeding *necessary*, the utility of this special kind of drawing would be practically destroyed. Fortunately, however, it is not necessary; since all the edges of the cube are equally foreshortened, there is no reason why they should be shown as foreshortened at all; and, accordingly, in Fig. 43, an *isometrical drawing* of the cube is made as shown in the view E, where each edge of the cube is shown in its true length, which is cd in the original elevation A; the isometric axes ca, cb, cd, making with each other angles of 120°, as in view D.

Drawings made in this manner, then, convey in one view ideas of the three dimensions, as do those made in perspective; in some cases they exhibit the peculiarities

of structure more clearly than the regular "working plans;" they are readily understood by many who are not familiar with common projections, and in making sketches they are often very useful.

But from the foregoing exposition of its principles, it will be quite obvious that the advantages of isometry

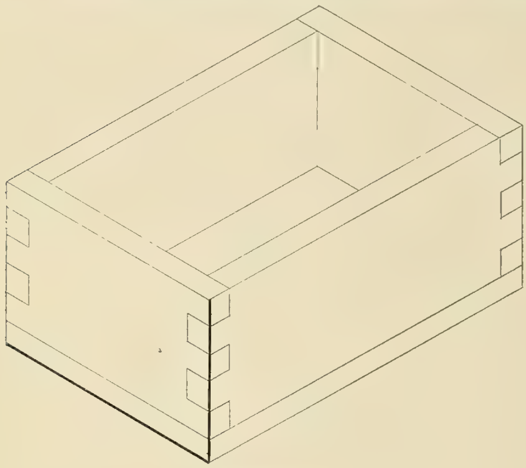


FIG. 44.

are more pronounced when the objects to be represented are bounded by right lines, of which the principle ones are respectively parallel and perpendicular to each other. This is clearly illustrated by the drawings of the box, Fig. 44; of the timbers with tenons and mortise, Fig. 45; and of the piece of flooring with its supporting beams, Fig. 46.

No dimensions are here given; but it is clear that since none but isometric lines are represented, the dimensions should be given in directions parallel to the isometric axes. And, again, if the object be too large

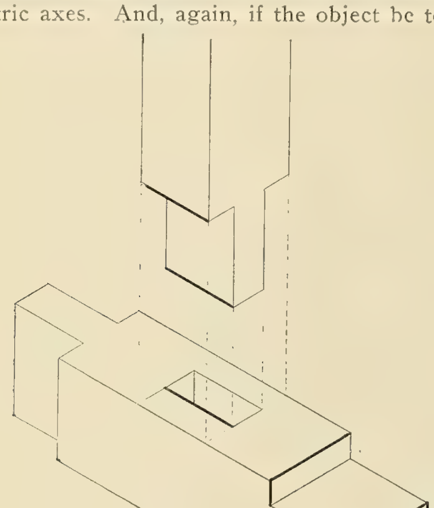


FIG 45.

to be drawn with the dimensions of their true length, we are at liberty to make an isometrical drawing, just as we may any other orthographic one, on any convenient scale, as 3 in. equal 1 ft., 1 1-2 in. equal 1 ft., and so on: in fact, to quote from the late W. E. Worthen, "the value of isometry as a practical art lies in the applicability of common and known scales to the isometric lines."

But though admirably adapted for making sketches or working drawings of "square" work like that shown in the last three figures, isometry is not equally advantageous in the representation of machinery in general, for this reason if no other; that every circle lying in an isometric plane is represented by an ellipse. A method of constructing this ellipse, which is both accurate and convenient, is shown in Fig. 47. The circle inscribed in the front face of the cube in the elevation A, is divided into quadrants by the vertical and horizontal centre lines, and the quadrants are bisected by the diagonals at the points l, m, n, o; through these points are drawn vertical and horizontal lines. All these right lines are readily drawn in the isometric view D, thus locating the points l', m', n', o'; the required ellipse must pass through these points, and also be tangent to the sides of the circumscribing parallelogram at their middle points. And since this parallelogram is a rhombus, its diagonals are perpendicular to each other, so

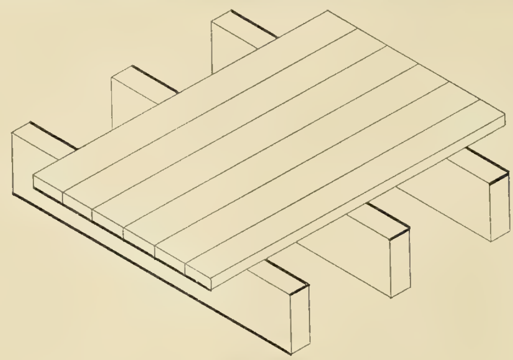


FIG. 46.

that $o'm'$ is the major, and $l'n'$ is the minor, axis of the ellipse.

If tangents to the circle be drawn at l, m, n, o, cutting off the corners of the square, the circle will be circumscribed by a regular octagon; the isometric representation of which is made by drawing at l', o', etc., perpendiculars to the diagonals. If similar perpendiculars be drawn to the diagonals of the adjacent faces, as shown, these will determine a plane perpendicular to the body diagonal of the cube through c, by which that corner of the cube may be cut off. If this process be repeated at the other corners, the result, as shown in Fig. 48, will be an isometric drawing of the crystalline form known as the "cubo-octahedron," bounded by six equal octagons and eight equal equilateral triangles. This affords an instance in which this mode of representation is much clearer and more striking than that of the ordinary front, side, and top views; as any one may easily convince himself by making a comparative construction.

Referring again to Fig. 47, it is to be observed that it is not necessary to draw the elevation A in order to construct the ellipse in the isometric view D. For if a semicircle be drawn on the edge cd as a diameter, divided into four equal parts at 1, 2, 3, and these points of subdivision be projected perpendicularly upon cd, the isometric lines through the points $1'$, $2'$, $3'$, will, by their

intersection with the diagonals, locate the points l', m', n', o'. Since all the edges of the isometric cube are equal, this construction may be made upon either indifferently—and again, since the faces of the cube are

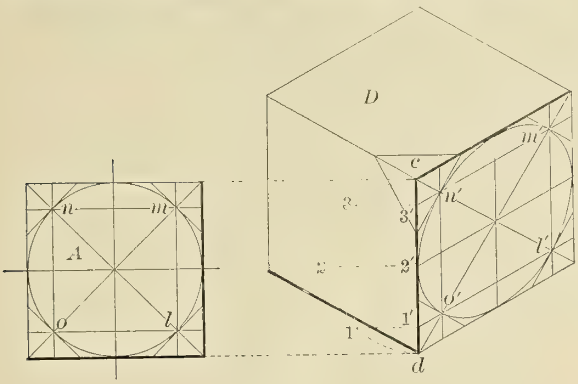


FIG. 47

isometrically represented by similar and equal rhombuses, the isometric representations of circles inscribed in all these faces will be equal and similar ellipses.

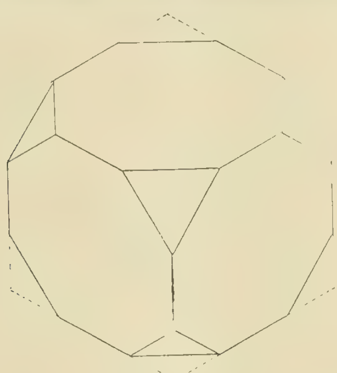


FIG. 48.

In Fig. 49 are shown two methods of graduating the isometric circle, represented by the ellipse inscribed in the rhombus *acbd*.

First Method.—At *e*, the middle point of *db*, draw *ef*,

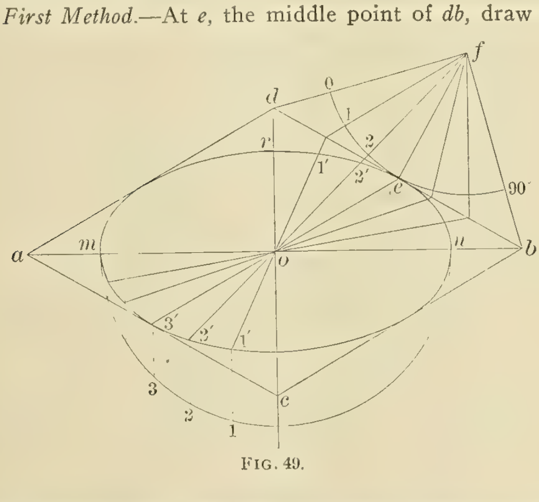


FIG. 49.

perpendicular to *db*, and equal to $eb = ed = eo$: then $dfb = 90°$. About *f* describe a quadrant with radius *fe*: graduate it as desired, and draw through the points of division radii from *f*, as *f1*, *f2*, etc., and prolong these radii to cut *bd*: from the points of intersection draw lines to *o*, the centre of the isometric circle; these will cut the perimeter in *1'*, *2'*, etc., thus giving the required graduation.

Second Method.—About *o*, the centre of the ellipse representing the circle, describe a semicircle whose diameter is *mn*, the major axis. Graduate this as desired, by the points *1*, *2*, *3*, etc.; from these points draw perpendiculars to the major axis *mn*, cutting the perimeter of the ellipse in *1'*, *2'*, *3'*, etc. Lines from these latter points to *o*, the centre of the ellipse, will include the representations of equal angles, if the semicircum-

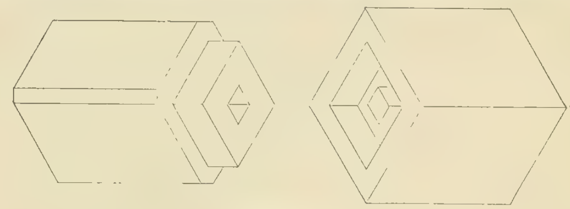
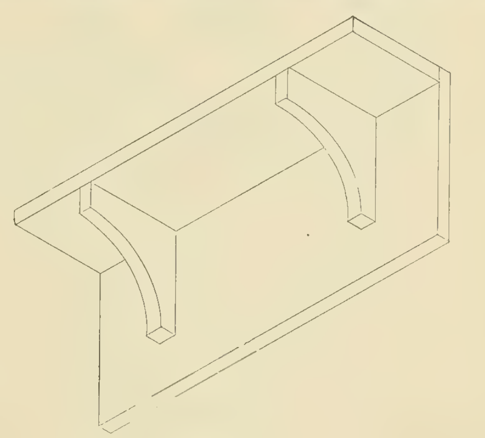


FIG. 50.

ference upon *mn*, as a diameter, is divided into equal parts.

Thus far, one of the isometric axes has been assumed to be vertical. But since it is the relative inclination of the isometric lines to each other which determines whether a drawing is or is not an isometric one, it follows that any direction at pleasure may be given to either one of these axes. Thus, in Fig. 50, one of them is horizontal, and it is very apparent in this case that the correspondence of the die to the matrix is more clearly shown by exhibiting their opposite faces than could have been done in any other way. By turning



FIG, 51.

the page a quarter round it will be seen that this could have been done equally well if the two pieces had been placed upright. Which leads to the consideration that isometry sometimes affords peculiar facilities for the illustration of subjects where views of the lower surfaces are desirable; as in the case of the shelf with its brackets in Fig. 51.

Of course, there will often be occasion to represent lines which do not lie in isometric planes. A method of dealing with these is illustrated by the drawing of the partially opened box, Fig. 52—and perhaps as well as it could be by any other subject. A sectional end elevation of this box is given below the isometric drawing;

and few words are needed to explain the construction of the latter. The non-isometric line $b'd'$ is determined by setting off on the vertical through c', the distances $c'a'$, $c'e'$, respectively equal to ca, ce, in the elevation, and then drawing parallel to the isometric axis $c'x'$, the offsets $a'b'$, $e'd'$, equal to ab, ed; then drawing $c'd'$, we have two sides of the parallelogram representing the

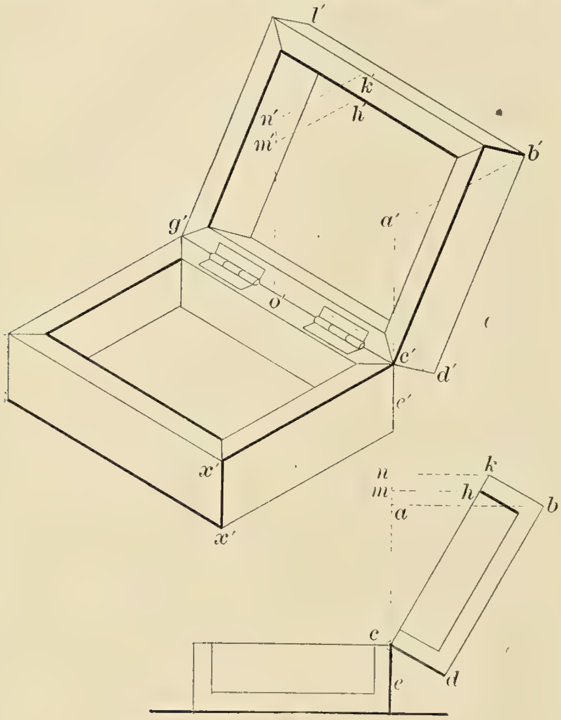


FIG. 52.

nearer end of the lid, which, though lying in an isometric plane, is bounded by non-isometric lines. To determine the apparent thickness of the front side of the lid, we may set up at any point o' on $c'\ g'$, the distances $o'm'$, $o'n'$, respectively equal to cm, cn, in the elevation, and then draw $m'h'$, $n'k'$, parallel to $c'x'$, and equal re-

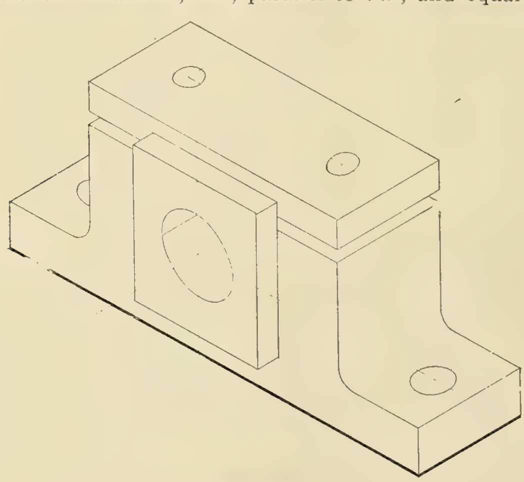


FIG. 54.

spectively to mh, nk, in the elevation. The thickness of the remote side of the lid may be determined in like manner. There is little more to be said, since it is apparent that all the longitudinal lines of the lid are isometric lines: thus $b'l'$ is equal and parallel to $c'g'$, etc., and all the others are parallel to either $c'd'$ or $b'd'$. This method of determining the extremities of non-isometric lines by means of offsets is always applicable, and, in fact, it is simply the application to isometry of the familiar method of locating a point in space by means of the ordinates drawn from the given point to the planes of projection.

But, though often useful in making sketches, isometric drawing is not well adapted to the general representation of machinery, not only because many, if not most, of the circles involved must be represented by ellipses, but on account of a very unpleasant apparent distortion, which will be at once appreciated by a glance at Fig. 54, which is an isometric drawing of the pillow-block shown in plan and elevation in Fig. 53. This is but a minor case. The distortion becomes more aggravated and pronounced with the complexity of the mechanism; so that it may be accepted almost as a truism, that isometry is not well adapted to the representation of assembled machines, however serviceable it may be in the making of sketches and in the representation of minor details.

This topic should not be dismissed without some illu-

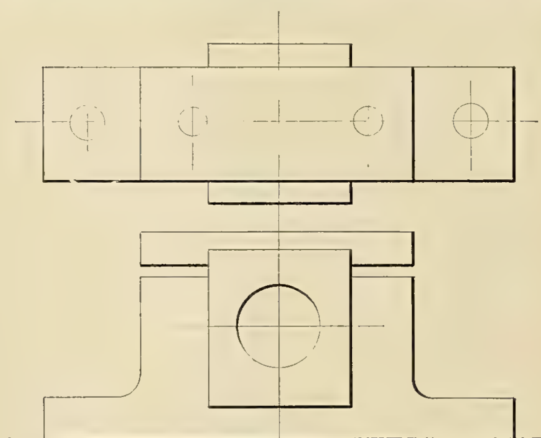


FIG. 53.

sion to the use of shadow-lines in isometric drawings. In relation to this (referring to Fig. 43) it is, we believe, a common practice to consider the light as falling in the direction of the body diagonal through a toward f in the view E. In that case the upper side and the left side of the cube would be illuminated, while the face bd would not be. In these circumstances, the edges cb, cd, de, and, in point of fact, bh, would cast shadows. We have purposely mentioned bh last because, in our opinion, it should not be made a shadow line at all, for the very object of shadow lines is to produce the effect of relief, and make the lines thus distinguished seem nearer the eye than others; whereas bh is conspicuously the most remote line in the drawing.

It is proper to give bc and cd a moderate thickness, since they are nearer to the eye than bh, and they do cast shadows, supposing the light to fall as above indicated. But on the other hand, they are the intersections of planes, both of which are visible in each case; and on this account the thickness of the line casting the shadow should be but a very little greater than that of the ordinary outline. There remains, then, the line

.de, to which the preceding arguments do not apply; but again, this beyond question is apparently a receding line, and nothing could more effectually destroy the impression that it is so than the very common error of inking it in with a bold, broad stroke.

Finally, then, all considerations point to one conclusion—that in isometric drawings the shadow lines should be manipulated with a leaning to the side of mercy, and never be made of so pronounced and emphatic a character as they may properly be made in the execution of ordinary "working plans," such as have previously occupied our attention.

NEW PUBLICATIONS.

The volume for 1900 of the Record of American and Foreign Shipping, which is the thirty-second annual issue of this valuable register and classification of shipping, is now being delivered to subscribers. The Record contains full reports and particulars of about 17,000 vessels of all classes and nationalities; rules for the construction and classification of steel, iron, and wooden vessels; rules for the construction and survey of steam machinery and boilers for vessels; provisions for the installation of electric lighting and power apparatus on shipboard, and much other valuable information of special importance to underwriters and all firms or persons interested in shipping. Besides the usual full information for the benefit of subscribers in the way of rules for construction with accompanying illustrations and tables—all of practical value—the work contains such features as list and addresses of prominent shipbuilders, dry docks, marine railways, marine machinery and boiler constructors in the United States; list of vessels whose names have been changed; also compound names, indexed by the last name; names and addresses of owners of vessels classed in the Record. The work is approved and endorsed by the important boards of underwriters in the United States, and is accepted by merchants and underwriters throughout the world as a standard register and classification of shipping. This excellent index has been thoroughly revised to date, and contains a large number of classifications not included in previous issues. The new Record is published by the American Bureau of Shipping, No. 37 William street, New York.

The Royal Navy List Diary and Naval Handbook for 1900 has just been issued by Witherby & Co., 326 High Holborn, London, price by post, three shillings and eight pence. For those having use for such a work it is an excellent combination of diary—one page 6 in. by 9 in. for each day—calendar and information needed by mariners. Naval matters are also given a good deal of mention, and this includes a sketch of "Naval Progress of the Year," by L. G. C. Laughton. To this is added a valuable comparative table of battleships of the first class of all the great naval powers, which gives totals of vessels built or building as follows: Great Britain, 45; France, 17; Russia, 15; United States, 12; Italy, 12; Germany, 10; Japan, 6. Another feature of real value is the Astronomical Summary which occupies several pages. The diary is bound in boards.

The small revenue cutter *Seminole*, for service at New York harbor, has been completed at the Columbian Iron Works, Baltimore, Md.

ENGINEERS' DICTIONARY.—XXIII.

Indicator—An instrument by means of which a cylinder using steam or other vapor, gas or liquid is made to give its own history of the continuous relation between pressure and volume throughout the stroke. The card or diagram thus drawn shows whether the valve gear is working properly in its distribution of the steam to the cylinder, and furnishes likewise the means for computing the *indicated horse-power*. The operation of the instrument requires two main features. (1) A movement proportional to that of the piston, and (2) a movement proportional to the steam pressure at any instant. The first movement is communicated to a strip of paper and the second to a pencil moving at right angles to the first. The diagram resulting will, therefore, show continuously the relation between piston position and pressure as desired. In Fig. —, showing an indicator, *A* is a light drum, which is given a motion of rotation about its axis by means of a cord wound around its lower end as shown, and attached at the other to a piece having motion proportional to that of the piston. The circum-

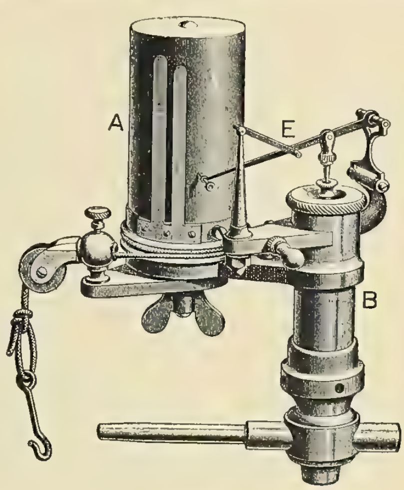


FIG. 82.

ference of the drum is usually from 3 to 5 inches, so that the movement of the piston must be reduced in proportion before connecting with the drum cord. The device which accomplishes this is known as the *reducing motion*, and by its means the drum moves back and forth in constant proportion to the movement of the piston. The strip of paper is attached to this drum by means of clips, as shown, and thus the first of the necessary motions is obtained. *B* is a cylinder within which is a nicely fitted piston. The steam is admitted below the piston, thus urging it upward, while a coiled spring fitted above balances by its compression the varying pressure of the steam. In order to avoid distortion of the diagram as a result of the inertia of the piston in its motion up and down, it is found desirable to have the motion of the piston itself quite small, and to magnify this by a system of light levers, *E*, called the *pencil motion*, and carrying at the extremity the pencil point which traces the diagram on the paper. These springs are carefully adjusted, so that the vertical motion of the pencil shall be proportional to the pressure of the steam per square inch, and according to convenient scales, with

which each spring is marked. These scales may vary from 10 to 100 lb. per inch or higher, according to the pressure employed. The pencil motion is so mounted and attached to the piston-rod that it may be moved about horizontally without disturbing the action of the steam on the piston. By this means the pencil may be moved up to the drum or withdrawn from it as may be desired. In taking a card the drum cord may first be connected with the reducing motion, and the steam then admitted to the indicator cylinder. When everything is working properly the mounting of the pencil motion is swung about the cylinder until the pencil point rests lightly on the paper for one revolution (or longer if desired), and the operation is complete. After thus taking the card it is customary to draw the *atmospheric line*, or line of atmospheric pressure. To this end the cock which closes off the steam is so made that when closed it also connects the space below the piston with the air. The pencil being then brought up to the card, the desired line is traced. See PQ, Fig. 81.

Indicator Barrel—A term frequently applied to the drum of the indicator, as before described.

Initial Pressure—The pressure in the cylinder of an engine at the beginning of a stroke.

Injection—A general term used in reference to the condensing water for the condenser of a steam-engine, or to its admission to the circulating pump.

Injection Valve, Cock, Pipe, etc.—See INJECTION.

Intermediate Cylinder—In a multiple expansion engine one of the cylinders, into which the steam passes from the first or high pressure, and before reaching the last or low pressure. See ENGINE.

Internal Feed Pipe—The continuation of the feed pipe inside of the boiler to the point or points of discharge.

Inverted Engine—A vertical engine with the cylinder above and crank-shaft below, as in the usual marine type. See ENGINE.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—What is the benefit of or objection to tail rods?

MARINE ENGINEER.

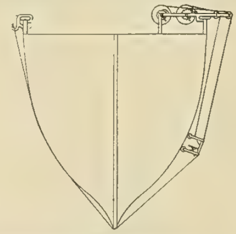
A.—The use of tail rods is a matter on which a considerable difference of opinion exists. Some builders use them and others in similar cases do not, but in general tail rods do not appear to be as extensively used at the present time as in former practice. When the cylinder diameter is large, and the stroke short, tail rods are undoubtedly of service in preventing tilting of the piston in the cylinder. Large pistons often wear the sides of cylinders unevenly when the crosshead wears out of line, and the tail rod is intended to prevent this. In merchant practice one chief objection to them is the increased number of stuffing boxes to be packed, though in these days of perfect metallic packings this objection should be more on the score of cost than trouble. To get rid of the stuffing boxes tail rods have been frequently incased in a pipe with flanged end, bolted on to the cylinder top at the lower end and closed at the upper end. The rod passes through a composition bushing in the cylinder cover up into the pipe. Small engines are also frequently fitted with tail rods, such as those on tugs. In the case of horizontal engines tail rods are of use in keeping the weight of the piston off the bottom of the cylinder. We believe they are used on modern locomotives to some extent, and on large horizontal stationary engines they are sometimes fitted with a shoe on the outer end working in a slide.

SELECTED MARINE PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

634,329. Diver's stage for cleaning ships' hulls. W. P. Freeman, New York, N. Y., assignor to the Electric Stone Cleaning and Renovating Company, Jersey City, N. J.

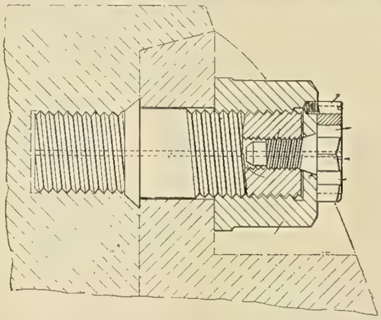
CLAIM.—An adjustable seat or stool within an open frame, which is supported from the deck of the vessel



by ropes connected to windlasses. By means of the ropes the frame is guided and moved along the hull.

633,376. Means for securing propeller blades. Lewis Davies, Liverpool, England.

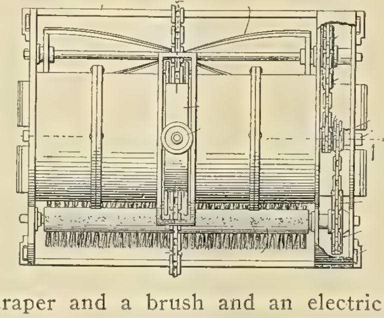
CLAIM.—Improvements reside in details of the construction of the studs and cap-nuts. The studs screwed into the boss are each formed with a longitudinal pas-



sage and a screw-threaded hole, a reversely-threaded cap-nut is formed with the central aperture, and a set-screw is inserted through this aperture into the hole in the stud.

633,910. Machine for cleaning ships' bottoms. John Schnepf, New York, N. Y., assignor of one-half to W. C. Doscher, same place.

CLAIM.—Within a frame adapted to be passed under and around the hull of the vessel by means of a cable



are a scraper and a brush and an electric motor to drive them. It is claimed that the iron in the body of the vessel will attract the magnets of the motor and hold the device close to the ship.

MARINE ENGINEERING.

Vol. 5. NEW YORK, FEBRUARY, 1900. No. 2.

U. S. FLOATING DRY DOCK AT ALGIERS, LA.—LARGEST IN THE WORLD.

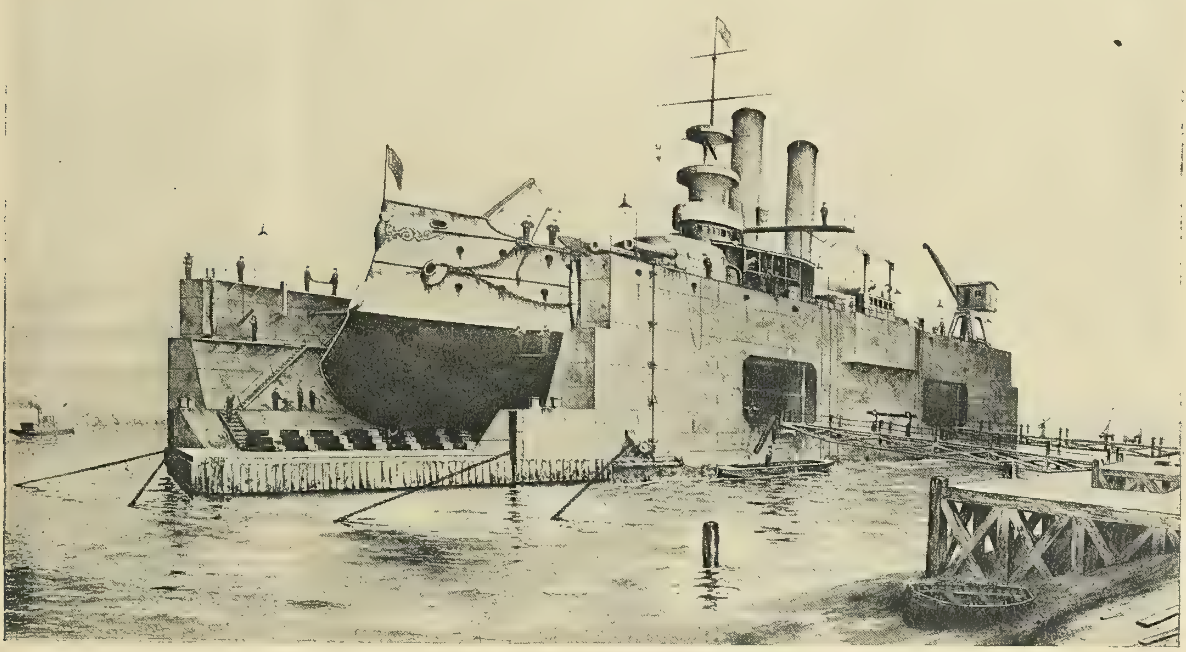
In considering the type of dock, whether sunk or floating, to be located at the U. S. naval reservation at Algiers, opposite New Orleans, La., the local physical characteristics of the site were determining factors in the decision.

With the strong current of the Mississippi rendering it difficult and at times impossible to turn a ship across it; with a soil of clay and sand affecting the stability of a sunk dock, and, finally, with a difference of nearly 20 ft. between high and low water stages of the river, adding enormously to the cost of a sunk dock, it was easily apparent that a floating dock alone could meet these conditions.

Accordingly, in the Act of May 4, 1898, Congress made an appropriation for a combined floating and graving dock of steel, capable of lifting an ironclad of 15,000 tons, with a draft of 27 ft., to be located at the Algiers naval reservation.

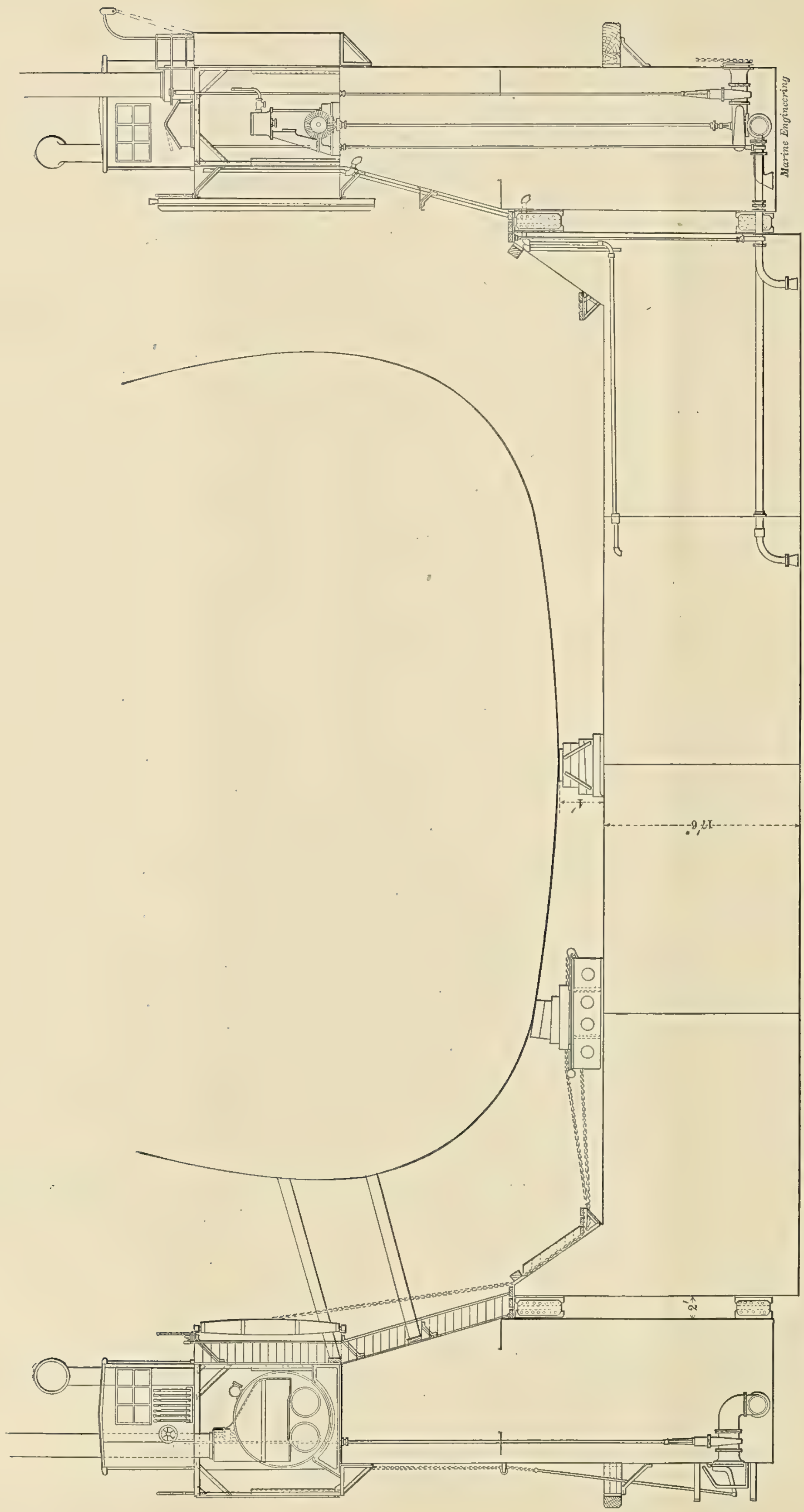
In August, 1898, bids for this dock based on "general specifications" were called for by the Bureau of Yards and Docks, bidders being free to present their own plans, with a limit of cost of the "entire works" of $850,000.

The proposal of the Maryland Steel Co., with plans drawn by Clark & Stanfield, of London, England, was found to be lower in price ($810,000) than its single competitor, and was considered to be of greater merit in other particulars. The contract was therefore awarded to the Maryland Steel Co. on its bid of $810,000, which includes the cost of shore connections, towage, and insurance. This contract was executed in April, 1899, and must be completed in November, 1900, a period of 18 months.

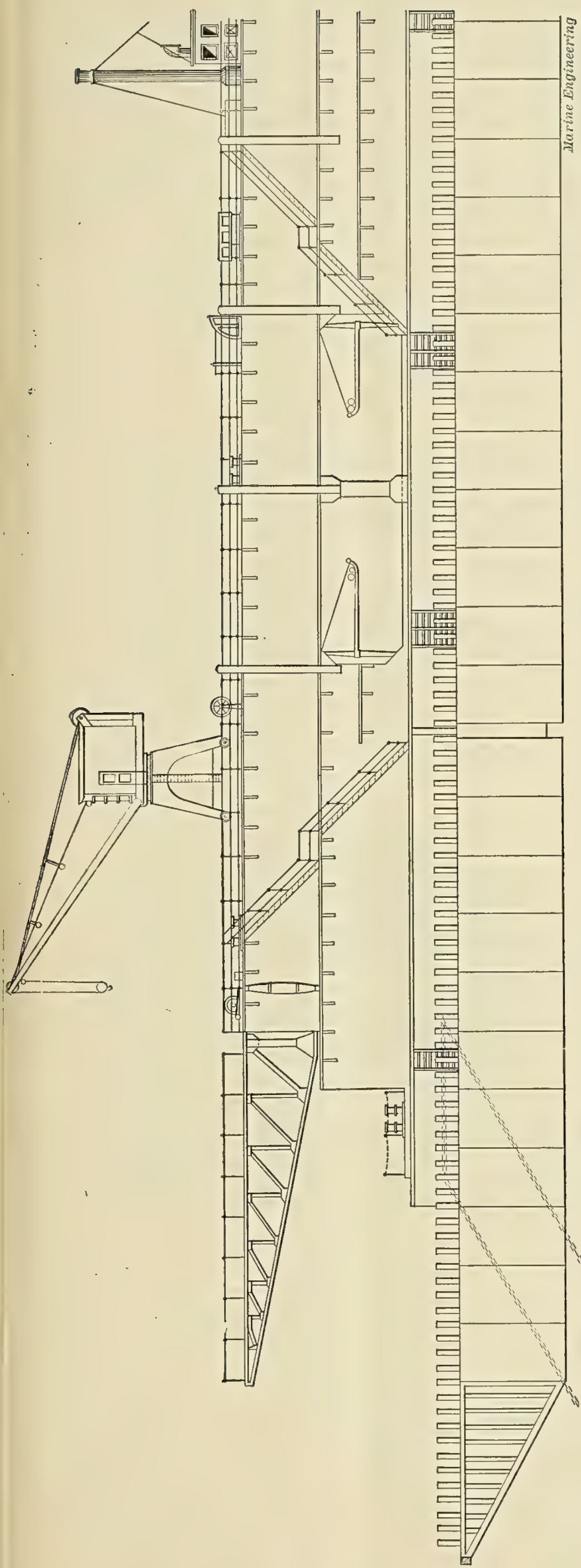


SKETCH SHOWING U. S. FLOATING DOCK FOR ALGIERS, LA., AS IT WILL APPEAR WITH BATTLESHIP DOCKED.

The first proposal of the company was for a lifting capacity of 15,000 tons, but the 2 ft. of freeboard



CROSS MID-SECTION OF U. S. STEEL FLOATING DOCK FOR ALGIERS, LA., NOW UNDER CONSTRUCTION BY MARYLAND STEEL CO., SPARROW'S POINT, MD.



HALF LENGTH OUTBOARD PROFILE OF U. S. STEEL FLOATING DOCK FOR NAVAL RESERVATION, ALGIERS, LA.—DESIGNED BY CLARK & STANFIELD, LONDON.

required by the Bureau's specification was secured by the use of gates. This was not allowed by the Bureau, and the plans were modified by increasing the depth of the pontoons, so that with the increased power, and without the use of gates, a 15,000-ton ship could be lifted 2 ft. above the surface of the water. These modified plans were accepted, with the result that the Navy will acquire a dock with a maximum capacity of 18,000 tons, when the floor is awash, or 15,000 tons with a freeboard of 2 ft. In effect the dock will be the most powerful floating dock in the world, and will be able to lift the largest ship ever built.

The designers, Clark & Stanfield, who have also made plans for many other docks, including the Havana naval dock of 10,000 tons, and the Stettin commercial dock of 11,000 tons, have in the Algiers dock improved on the two earlier docks mentioned in the direction of strength and simplicity.

The following are the general dimensions of the Algiers dock:

Length over all	525 ft.
Breadth " "	126 ft. 2 7-16 in.
Breadth between walls	100 ft.
Depth over sills	28 ft.
Depth of pontoons	17 ft. 6 in.
Height of keel blocks	4 ft.
Maximum draft	49 ft. 6 in.
Number of pontoons	3
Length of middle pontoons	242 ft.
" " end "	141 ft. 3-8 in.
" " walls	395 ft. 5-8 in.
Width " "	12 ft. 1 1-8 in.
Clearance of walls and pontoons	2 ft.
Freeboard of walls, 28 ft., on sills	4 ft. 9 in
Number of keel blocks	209
Weight of dock	5,702 tons
" " equipment	420 tons
" total of dock	6,122 tons
Lifting powers of dock (maximum)	18,000 tons
Time of lifting " "	3 1-2 hours
Cost of dock	$810,000
Time penalty for delay	$200 per day

The material used is generally acid or basic open hearth steel.

The specifications require that the dock shall have transverse strength and stiffness sufficient for docking a battleship of 15,000 tons with her entire weight carried on the keel blocks. The dock must not careen more than 3 deg. under the most unfavorable conditions of loading—providing for the vessel landing 2 ft. off the longitudinal center line and subject to a wind pressure of 30 lbs. per sq. ft. The greatest longitudinal deflection allowable will be 1 in 3,000, with most unfavorable load, and, similarly, the greatest transverse deflection is limited to 1 in 1,800. The stability of the dock will be enormous. Carrying a 15,000-ton battleship 2 ft. above the water, the stability of the two combined will be fifteen to twenty times that of the ship floating in the water.

As designed the dock has three pontoons rigidly secured to the side walls by two horizontal rows of fastenings. The end pontoons have blunt noses with 30 ft. of the ends without buoyancy. Each pontoon has three longitudinal bulkheads, the two outer ones being water tight, while the middle one is designedly left with small openings. 'Thwartship bulkheads are worked every 10 ft., every fifth or sixth being water-tight. At the sides,

the flat floor of the pontoons is carried up 8 ft., in the shape of altars, to give increased stability. These pontoons are rigidly secured to the walls by two parallel rows of fastenings; these consist of pairs of steel T lugs riveted to the skin of the walls and pontoons, spaced every 10 ft., and of the following dimensions:

Length of flange riveted to skin	1 ft. 3 1-2 in.
" " " projecting	10 in. by 1 1-2 in.
" " upper joint	4 ft. 3 1-2 in.
" " lower joint	3 ft. 3 1-2 in.

Joints are made by fish plates 3 1-2 in. shorter than the lugs, 1 ft. 4 in. broad by 7-8 in. thick, with 2 in. holes. Steel pins, 2 in. dia., with tapered ends, are used.

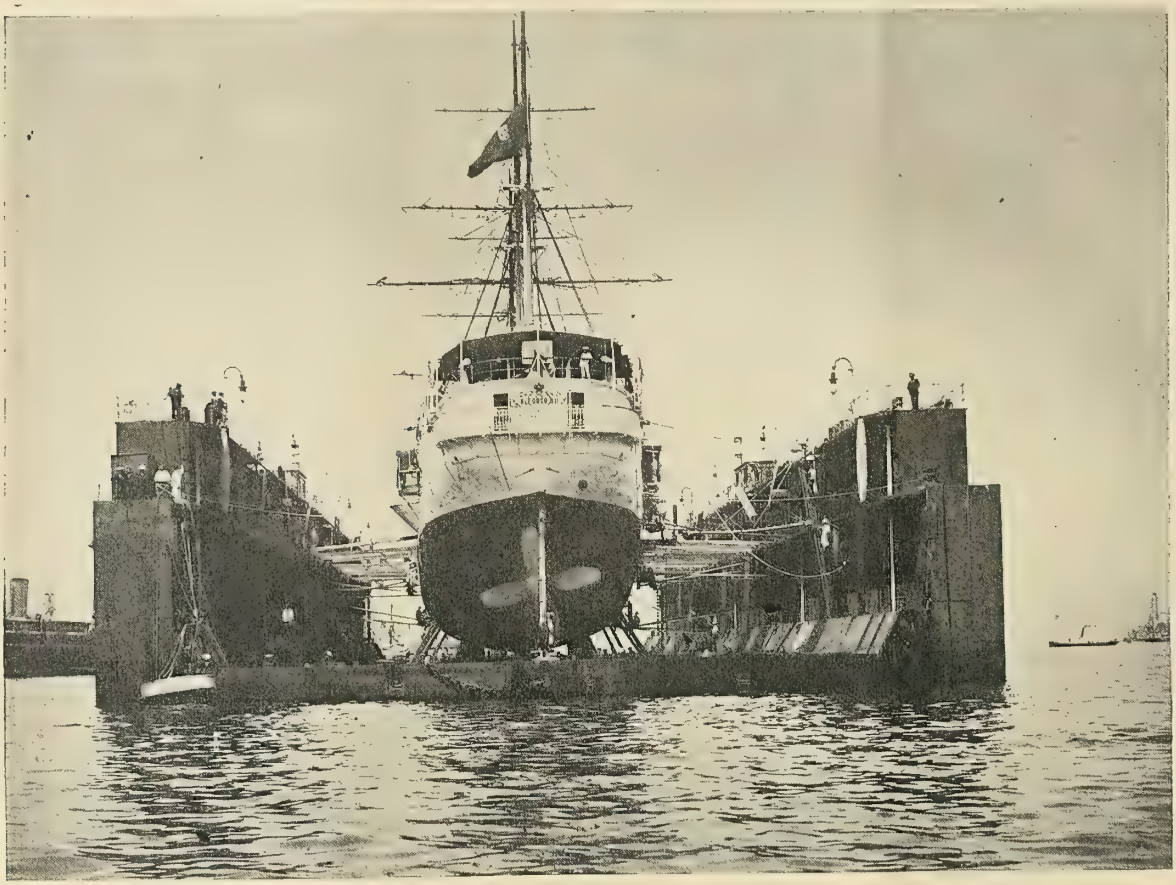
The walls, while affording a certain amount of lifting power, primarily serve to give the dock stability and regulate its descent when the pontoons are submerged. They have four watertight divisions and contain the pumping plant and living quarters of the crew. On the face next the shore are built two projecting turrets to which the mooring booms are secured, with large gangway openings to admit of easy access to the floor of the dock.

Moorings of the dock comprise four 2 in. chains, made fast to screw or mushroom anchors, planted up stream, calculated to hold against a maximum current of 6 knots, with a wind pressure of 30 lb. to the sq. ft., the ship being in or out of the water.

The dock is secured to the shore piers by a pair of hinged swinging booms, 80 ft. long, which are made fast to the turrets on the wallface and at the shore ends to heavy steel columns built in the foreshore. They are themselves fitted with tracks as gangways, and must carry a rolling load of 20 tons on two wheels. Considered as struts, they must stand push or pull of 180 tons each. In effect these booms work like a pair of parallel rulers; by veering or heaving in chain, the dock can be dropped alongside the bank or hauled out in the stream. Cross chains are provided to prevent the dock being blown upstream by the wind.

The piers are two in number, of light construction, and are carried from the pierhead to a point on the farside of road and on a level with the top of the levee. They are fitted with tracks and must carry a rolling load of 40 tons. They are built as steel girders on light columns or screw piles, with a total length of 240 ft.

As fenders timber walling of pine 18 in. by 12 in. at and below the level of the pontoon deck is carried all around, and at the bows a separate additional fender is worked 5 ft. lower.



FLOATING DOCK AT HAVANA, WITH SPANISH WARSHIP ON THE BLOCKS—END VIEW.

Adjustable bilge blocks, capable of being shifted either in or out, as well as in a longitudinal direction, are provided. In the case of a short heavy ship, a number of these blocks can be concentrated under a heavy turret. In addition strong wallings are provided at different heights along the face of the walls, so that shores may be wedged in between them and the armored belt, and thus considerably reduce the tendency this localized weight has to crush in the bilge of the ship. Four me-

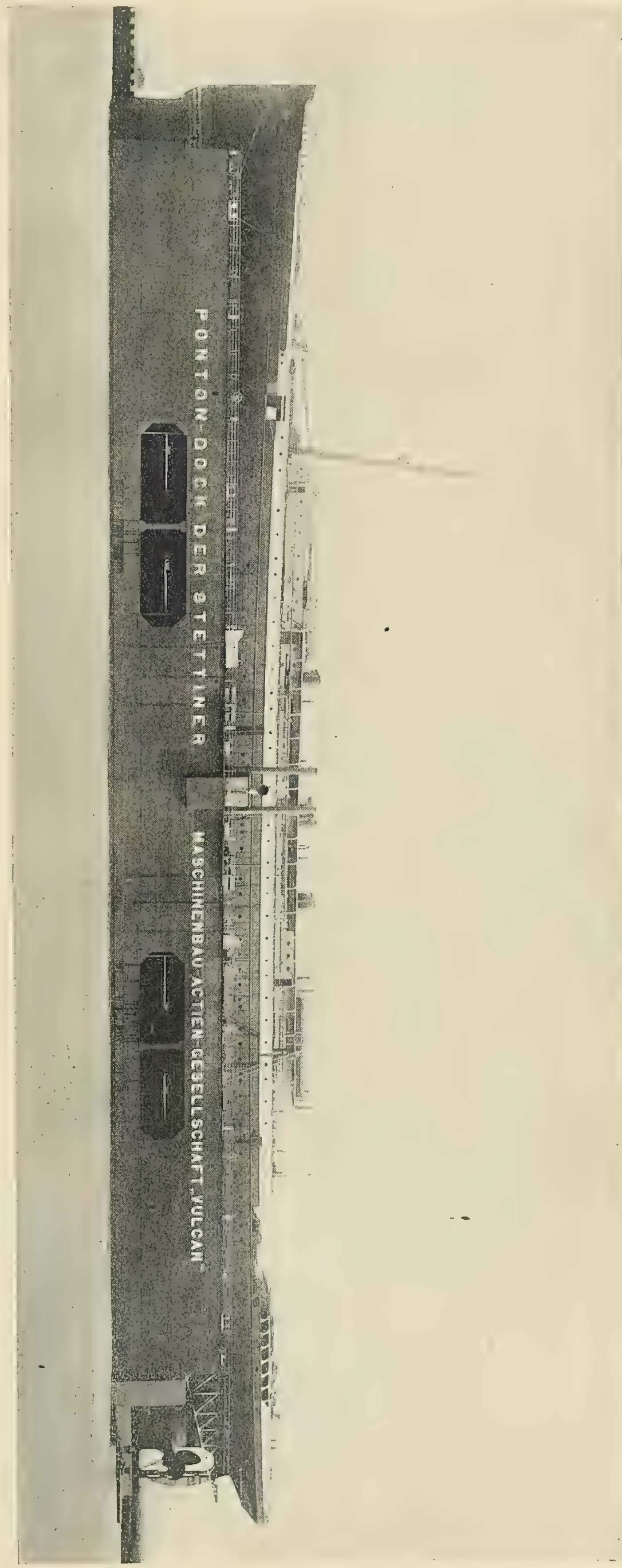
chanical centering shores are provided, also roller fenders, capstans, etc.

Ample pumping capacity is provided, each wall having four pumps on a main drain. The pumps are of the horizontal discharge type, and steam for their operation will be supplied by an installation of Babcock and Wilcox water tube boilers. A separate engine is provided for each pair of pumps, and a separate boiler for each engine. The steam pipes are so arranged that either engine can take steam from either boiler; each boiler, engine and pump is, therefore, duplicated in each wall; and, further, each wall duplicates the other, so that if only one boiler, engine and attendant pump remain at work the whole dock can still be lifted. A complete washing-down plant, worked by a separate Worthington pump, is provided in each wall. By the alteration of a coupling, it can be used as a drainage service for the pontoons.

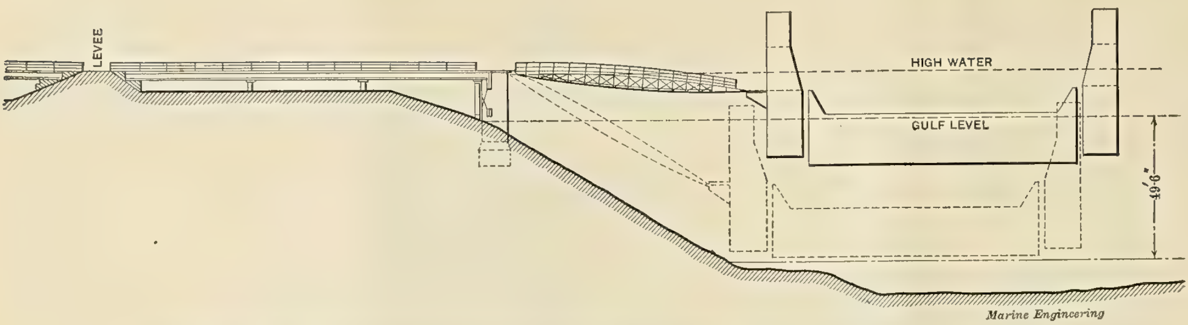
The working of the whole dock is done from two central positions, one on each wall. Here are grouped in the valve house ordinary signal levers, which by rods and cranks connect to the different valves. Each valve house is in direct communication by speaking tubes with the engine rooms, so that the man in charge can manipulate every valve, both water and steam, for manœuvring the dock without quitting his station.

One of the most useful qualities of the Algiers dock is its "self-docking" system, by which any portion of the exterior surface can be made accessible for repairs, painting, or inspection. To reach the bottom of one of the walls, say the port one, it is only necessary to heel the dock to starboard. In the case of the pontoons, the middle one is made large enough to raise those at the ends out of water. Suppose it is desired to get at the bottom of the middle pontoon: the dock is allowed to float light; men then knock out the tapered pins of the two rows of fish plates which secure this pontoon to the side walls; then the dock is allowed to sink, the middle pontoon floating free, until the lower row of fish plates on the pontoon is level with the upper row on the walls; the pins are then driven in, the dock pumped out, and the middle pontoon is lifted clear of the water—due to the difference of height between the rows of fastenings. To undock, the reverse course is followed. The end pontoons are similarly treated. The interior of the walls and pontoons is easily accessible through numerous manholes.

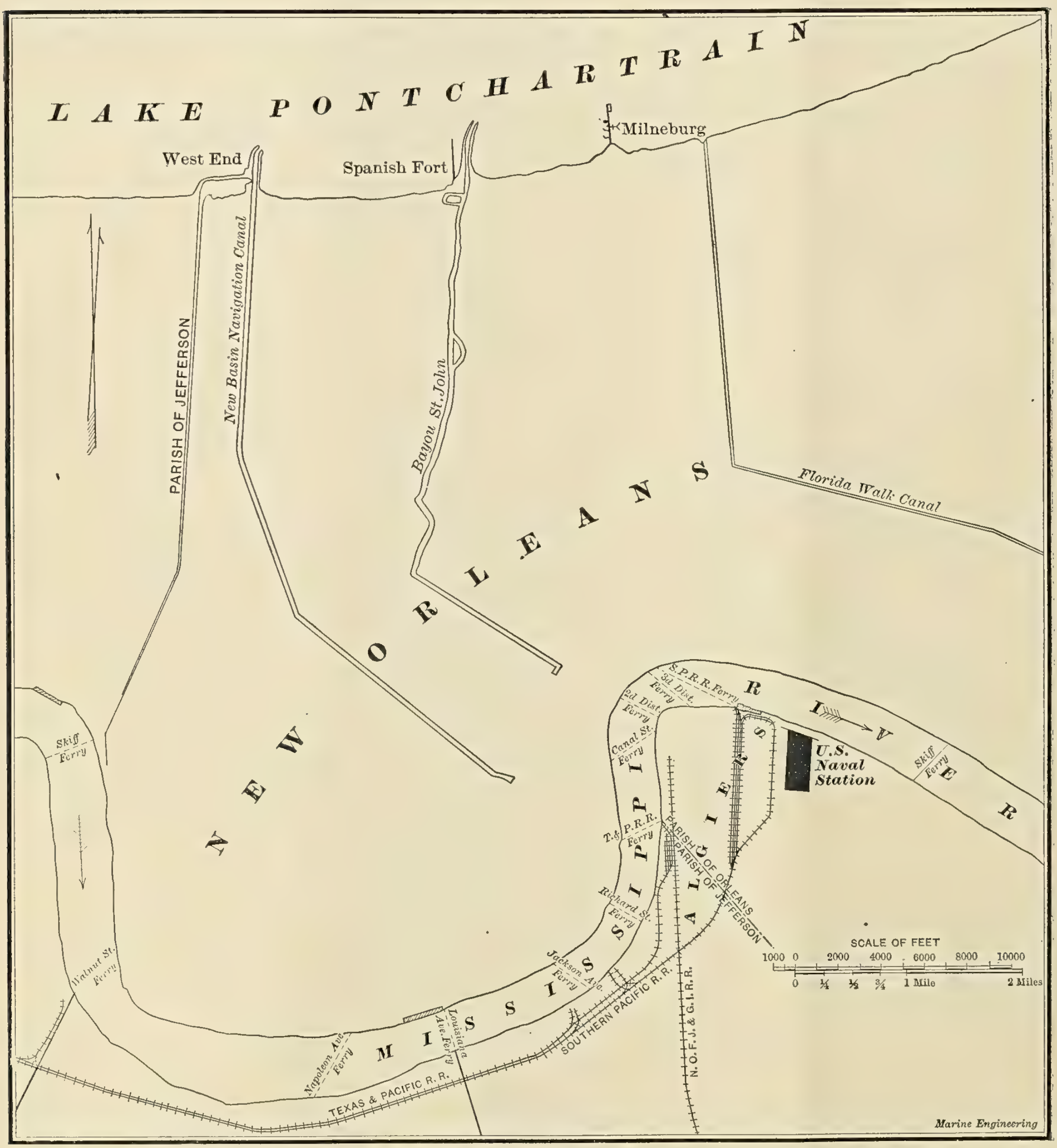
Should a disabled ship draw one or two more feet than the capacity of the dock



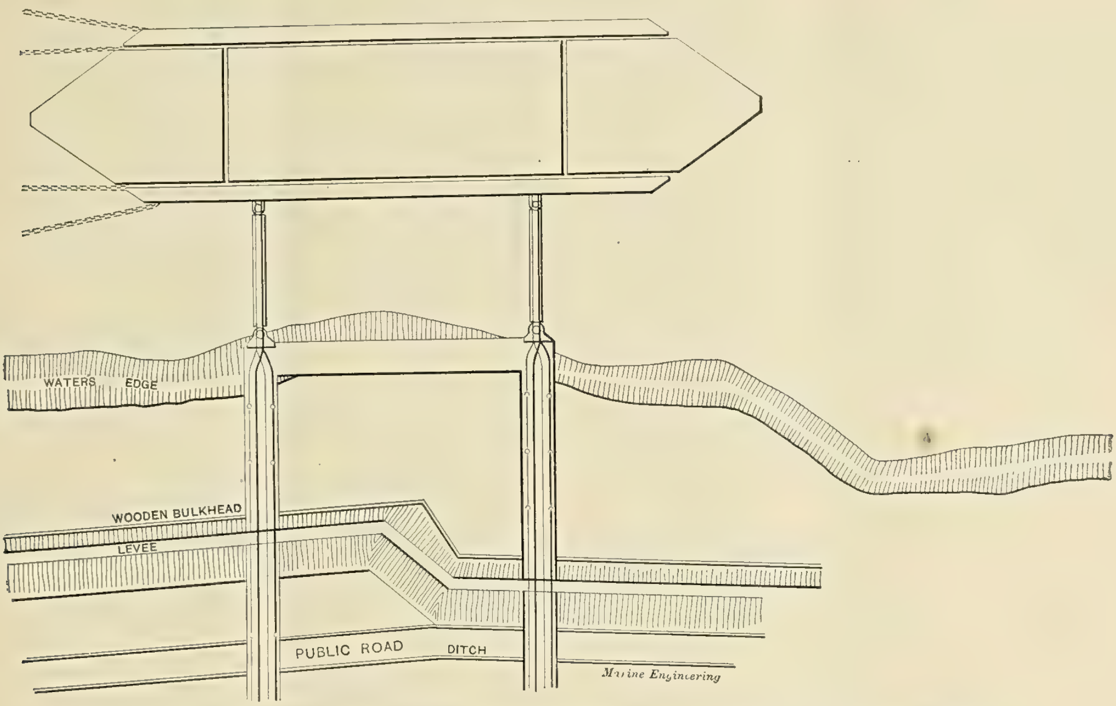
SIDE VIEW OF THE STETTIN, GERMANY, STEEL FLOATING DOCK WITH TRANSATLANTIC LINER DOCKED—SAME TYPE OF DOCK AS THAT FOR U. S. STATION, ALGIERS, LA.



SKETCH SHOWING CONTOUR OF BANK AND RIVER BED AT DOCK ANCHORAGE IN MISSISSIPPI RIVER.



SKETCH MAP SHOWING LOCATION OF U. S. NAVAL STATION AT ALGIERS, LA., AND SURROUNDINGS.



PLAN SHOWING SHORE CONNECTIONS OF FLOATING DOCK AND RIVER BANK AT ALGIERS, LA.

LAYING DOWN THE STEEL DRY DOCK AT SPARROWS' POINT YARD—A RECENT PHOTOGRAPH.

permits, the dockmaster would not hesitate to sink the dock the extra depth, as the walls have a minimum freeboard of 4 ft. 9 in. Also, should a ship, from any cause, have a list, the dock could be given the same list within limits, the ship taken in, and the two then brought to an even keel.

Upon securing the contract for the construction of the Algiers dock the Maryland Steel Co. made extensive preparations for handling the work accurately and expeditiously. A portion of the shipyard at Sparrow's Point was fenced in as a dock construction department, and the work placed in charge of S. Anderson. A machine shop has been erected and fully equipped with all the necessary machinery. Tracks have been laid and pipes for the compressed air used in riveting. The berth itself is a huge hole scooped out of the foreshore, with the dredged material thrown up to form a coffer dam. In this berth a platform of heavy timbers has been built, and running down either side of its center line are two trestles carrying the tracks for traveling cranes, which latter will place in position every plate and angle used. It is proposed to erect those frames of the walls and pontoons carrying the joint lugs, put in the fish plates, insert the pins, and make the joint, before the side plating, stringers, decks, etc., are riveted up. The dock will therefore be built round these joints, which form, so to speak, a base from which everything will be faired. When the dock is completed, the water will be let in and the dock floated without undergoing any of the stresses due to launching from ways.

A large amount of material has been received and machined ready for erection and the actual work of construction was commenced last month. With the facilities at command, it is hoped to have the dock ready to tow to the Gulf in about eight months.

Our frontispiece shows the new dock as it will appear when constructed and with a battleship docked, the drawing has been made in perspective to show more clearly the method of docking. The drawings published with this description show accurately the general construction of the dock and the approaches, and a map of the district shows the location of the naval reservation with respect to the immediate surroundings on the Mississippi. As is well known the flow of this river is subject to great fluctuations, as it drains such an enormous territory. The stages of the Mississippi River at New Orleans, as determined by the Canal Street gauge, under the supervision of the U. S. Department of Agriculture, are as follows:

Zero of guage is 2.53 ft. below mean gulf level.
Low water of December 30, 1876, reads zero.
High water of April 16, 1874, reads 16.2 ft.
High water of May, 1897, reads 19.5 ft.
Danger line changed from 13 ft. to 16 ft. on March 15, 1897.

In discussing this dock it is of much interest to consider the large floating docks at Havana and Stettin, which were also designed comparatively recently by Clark & Stanfield of London. The accompanying reproductions of photographs show both these docks in use, the Stettin dock with a transatlantic liner on the blocks undergoing alterations, and the Havana dock, shown endwise, after lifting a Spanish cruiser. The principal dimensions of the three docks are given comparatively in the following table:

COMPARATIVE DIMENSIONS HAVANA, STETTIN AND ALGIERS STEEL FLOATING DOCKS.

Dimensions, etc.	*Spanish Naval.*	*Stettin Commercial.*	*Algiers Naval.*
Length	450 ft.	510 ft.	525 ft.
Breadth inside	82 ft.	82 ft.	100 ft.
Water on sill	27 ft. 6 in.	24 ft.	28 ft.
No. of pontoons	5	3	3
Cost delivered	$579,000	$443,000	$810,000
Weight	4,400 tons	4,510 tons	6,100 tons
Power	10,000 tons	11,000 tons	18,000 tons

Both the Havana and Stettin docks were built by C. S. Swan and Hunter on the east coast of England.

S.S. DEUTSCHLAND.—At the yard of the Vulcan Company at Stettin, Germany, the new Hamburg-American twin screw S.S. *Deutschland* was launched last month in the presence of the German Emperor and members of the Government. The new vessel follows next after the *Oceanic* in point of size of ships now afloat and exceeds her very considerably in the matter of speed. Her dimensions are: Length, 662 ft. 6. in.; beam, 67 ft. 6 in.; depth, 44 ft.; gross tonnage, 16,000 tons; load displacement, 23,000 tons. With 33,000 I.H.P. the new boat is expected to develop a rate of speed of 23 knots at sea. The new steamship will have six decks extending the entire length and will have a number of special accommodations for cabin passengers, such as a play room for children, a passengers' gymnasium and a drill room on the promenade deck. The machinery of the *Deutschland* will include main engines of the quadruple expansion type, each having six cylinders: (2) H. P. 36 5-8 in. dia., (1) I.P. 73 1-2 in. dia., (1) second I.P. 104 in. dia., and (2) L.P. 106 3-8 in. dia., and stroke 72 3-4 in. Sixteen cylindrical return tube boilers will be fitted with a total of 112 furnaces. It is understood that the North German Lloyd Co. has ordered a similar ship from the builders, work upon which is to be commenced without delay.

RESCUE AT SEA.—When the Atlantic transport liner *Georgian* arrived in New York last month from London she had on board 35 persons, men, women and children, who were taken off the steamer *Ella* in mid-ocean. The rescue was made in a heavy sea at great risk to boat's crew of the liner. December 30 last the *Ella* left Perth Amboy, N. J., for Halifax, N. S., with 1,600 tons of coal. Captain Strange was accompanied by his wife and family. For several days after leaving port the collier met with terrific seas which battered and flooded the vessel, finally drowning out the fires. Signals of distress were answered one night by the *Georgian*, and with daylight the effort to save those on the *Ella* was made. A boat commanded by First Officer Field of the *Georgian* took off those on the *Ella* by mean of lines. The *Ella* was a steel vessel of 2,100 gross tons, formerly named the *Abydes*, and was owned in Germany. She was under charter to the Munson Line and had been engaged previously in the West Indian fruit trade.

An oil tank steamer supposed to be the *Helgoland* was wrecked in St. Mary's Bay, New Foundland, January 11, and all on board lost. All efforts to reach the vessel were ineffectual for several days after she struck, and when boats were able to reach the scene of the wreck the vessel was submerged. Many notable wrecks have occurred in that vicinity.

TACTICAL CONSIDERATIONS INVOLVED IN THE DESIGN OF THE TORPEDO-BOAT.*

BY LIEUT. A. P. NIBLACK, U. S. N.

Up to a very recent period there were a few large firms in Europe which had practically a monopoly in torpedo-boat construction, and which, in a measure, set the fashions, and ordained the types. To-day, however, both in Europe and the United States, almost any shipyard or marine engineering firm, without traditions or previous experience, seems willing to take contracts either on plans or designs of its own or on those furnished by the Governments interested. Owing to this breaking away from old traditions and to the enormous advances made in naval construction and marine engineering, we find a resultant uncertainty as to just what is the best type of torpedo-boat. The best means of approaching the question would seem logically to be through a study of its weapon, the torpedo, regarded as the only excuse for the existence of the boat.

An automobile torpedo, launched over water from a rapidly moving and oscillating platform, encounters many variable impulses tending to deflect it from its normal course. The wrong angle of incidence of the torpedo in striking the water may give too deep or too shoal an initial dive, or deflect the torpedo laterally. Moreover, each torpedo has its nice adjustments and peculiarities, which must be learned by trial runs, so that, in general, it may be stated that much practice must be had with a given boat and with each individual torpedo to insure the chances of hitting, when the torpedo-boat has survived the many perils which beset it in getting within striking distance.

It may be stated, roughly, that the highest development of the present type of torpedo is one about 16 ft. long, 18 in. dia., and carrying a charge equivalent to 110 lbs. dry gun-cotton. The highest pressure used in the air flasks to operate the engines is 1,500 lbs. per sq. in., giving a speed of from 30 to 32 knots at 400 yards, 28 to 30 knots for 800 yards, and 26 knots for 1,000 yards. There are, of course, innumerable sizes, shapes, and variations. Some carry twice the above weight of charge. Distance and speed are largely matters of pressure and size of air flask. Some unusually long ones, for coast defense, run as high as 30 knots for 1,000 yards and 24 knots for 2,000, but, for torpedo-boats, the above length of 16 ft. and diameter of 18 in. is about the limit for convenient handling, and for weights of mounts and accessories, as the weights increase unduly for small increments in dimensions.

The torpedo is not a delicate instrument, and, after seeing many trials under varying conditions, one comes to feel that it is almost animate; but, for all that, there is a popular mistrust of its ultimate value as a weapon, in spite of what its advocates claim for it; and yet, curiously enough, the world is not yet alive to the fact that a complete revolution has taken place in the status of the torpedo by recent inventions and improvements. It now has a secure and permanent place in naval warfare, and it only remains to accept the fact.

The first improvement is the application of the principle of the gyroscope to the steering rudders of the torpedo, and the second is the perfection of apparatus that will safely and accurately launch torpedoes from the under-water broadside of a rapidly moving ship. The latter practically does away with above-water discharge in large ships, and the former has doubled the accuracy of fire.

In the Howell torpedo, the invention of Rear Admiral J. A. Howell, U. S. N., the motive power is a fly-wheel spun up previous to launching, and the remarkable results in directive force and persistence of the torpedo by the gyroscopic action of the fly-wheel has led to its adoption in a miniature form as a separate attachment to an ordinary torpedo, involving no radical changes in design, since it takes the place of a certain amount of ballast and merely adds a pair of rudders and a few connections. The first practical design of this was by an Austrian, named Obry, and Whitehead and Company acquired the sole rights. The question of infringement of the Howell patents has not deterred others, and there is a successful one in Germany.

We had a naval commission at Fiume in November, 1896, to witness the first exhibition of the workings of the Obry attachment, and, later, a trial in the United States, which showed that it was "an excellent practical apparatus sufficiently robust for the conditions of use, not difficult of adjustment, and not requiring frequent adjustment, and its capacity for steering the torpedo in the course indicated by the direction of the axis of the torpedo at the moment of launching or in a course parallel thereto, after the first unavoidable deflections due to unfavorable conditions of launching, was such as to improve the performance of the torpedo 100 per cent."

One naval commission at Fiume made the following trials successfully, not once, but many times: Ordinarily the gear does not start up until the moment of launching of the torpedo, which act puts in operation a tightly wound clock spring, which, in turn, spins up the gyroscope and keeps it going. A torpedo-boat, at high speed, steaming past a target at some 600 yards distance, pointed its tube at the target, and, by a special arrangement, released the spring. The tube was then turned off the target about 45 deg. and the torpedo launched. The gyroscope, true to its principle, brought the torpedo back *parallel* to the original plane in which it was started in operation, and excellent targets were made. The course of the torpedo thus fired is a horizontal wave.

At Fiume, using the attachment, excellent results are obtained from fixed under-water launching at 1,000 yards, and, with improvements in air flasks as to volume and pressure, we may expect to see the effective range of torpedoes in naval warfare regarded as 800 yards, instead of being limited, as now, to 500 yards or less. Torpedoes, which are erratic, ordinarily, to the point of rejection, are fired successfully right along, using the Obry gear, and, in a recent trial, torpedoes were fired from an under-water broadside tube of a ship steaming 16 knots, and made excellent targets, using the attachment, although the permanent angle of deflection of the torpedo, due to the method of launching, was not known within 10 deg. As the Obry gear and the method of under-water discharge from ships have both been adopted in our navy, we may assume that in the future we may count tactically on these latest inventions being used, at least in large ships.

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.

If we consider the conditions under which a torpedo-boat may be reasonably expected to be effective against a ship or the ships of the enemy, we will find that an attack, to have a reasonable chance, must be a surprise. Hence darkness, fog, mist, snow, and rain are the favoring conditions. Heavy rains are particularly favorable since, for the defence, the eyes of lookouts are punished severely by the water, it is hard to keep men constantly at the battery, the searchlight is more than useless, sights are blurred, and outside noise is deadened by the fall of rain. Attacks are made in groups of boats, and it is this which we lose sight of in the United States. A single boat would only attack as a forlorn hope, and under most extraordinary circumstances. All torpedo-boat attack must be in groups, and must be, as in polo or football, or any other similar game, a question of "team work," of "interference," of strategy, head, and nerve. Of all things, it is a question of system. A ship or a squadron attacked simultaneously from various directions must destroy or drive off all the attacking boats or take the consequences. Feints will naturally be made. The first boat or boats discovered will advance fearlessly, dropping and scattering small incandescent buoys to disconcert the aim and create the illusion of numbers, and, if so fitted, use their searchlight. Under strong excitement it is peculiarly human to yield to the temptation of shooting at a light without reasoning. Meanwhile, some one or more boats will get in their torpedoes from an unexpected quarter. Numerous tests at manœuvres in many navies have shown that it is astounding how often torpedo-boats get in *without being seen* and when *expected.* Some people go so far as to say that the searchlight beam is the safest path of approach, and, in one navy, they practice running in it so as to get accustomed to the glare and to judge distances.

In approaching to the attack, previous to discovery, reduced speed must be used so as to avoid white bow waves, smoke, and flame, and that peculiar and far-sounding hum which accompanies fast-running machinery. Once discovered, or once within striking distance, high speed becomes important, but it takes some little time to attain it after having once slowed. As between a speed of 20 and one of 30 knots the time it takes to cover 1,000 yards is only as 90 seconds to 60 seconds. Can the 30-knot boat pass from 20 to 30 knots in 30 seconds? If you can build three boats of 22 knots for what two of 30 knots cost, and if the greater the number of attacking boats the better the chances, is it not wise to forego phenomenal speed? This craze for great speed is illogical and tactically it is indefensible. Back of it is generally an advertisement for somebody. People who handle torpedo-boats have never sanctioned it. What they do ask is that boats be built in groups on identical designs, and that every reasonable effort be made to standardize fittings. As long as fittings are standardized, we may improve groups progressively from year to year as experience dictates.

We are boxing the compass in our torpedo-boat building programme, and there seems to be no known relation between horse-power and displacement. The real excuse for the boats is that they shall carry torpedoes. Let us look abroad and learn lessons. To say that we have not yet had experience enough to warrant us in standardizing fittings is begging the question. From a military standpoint the standardizing is more important than that the fittings should be the latest complicated invention, largely experimental. It is a simple matter to decide, for instance, that all boats shall have the same size and type of water-tight doors, hatches, conning towers, hatch covers, manholes, bunker plates, anchors, cables, winches, steering engines, annunciators, telltales, galleys, deck chests, navigation supplies, fenders, reels, compasses, torpedo-cranes, awnings, whistles, sirens, bunks, mess tables, etc. This would do to start with, but the logical culmination of the idea is to build the boats in groups with interchangeable parts.

Before taking up the question of the proper relation between tonnage and horse-power for first-class torpedo-boats, let us look at some of the questions of detail, as illustrated by foreign practice. We regard it as essential, apparently, that a torpedo-boat of considerable size shall have twin screws. Great Britain has nearly 100 first-class torpedo-boats, varying in tonnage up to 130 tons, and of which only one has twin screws. Austria has 30 of from 78 to 134 tons, all single screw. In Italy twin screws are used above 100 tons displacement, and single screws for boats of less tonnage. In France, with some 225 or more torpedo-boats of from 75 to 150 tons displacement, all have twin screws; but, below 75 tons, single. In Russia, of the first-class boats of from 75 to 140 tons, only one group of seven has twin screws, although there are several other groups building in which this is also true. The vast majority are, however, single screw. In the Baltic countries, Germany, Denmark, Norway, and Sweden, practically all boats are single screw and have bow torpedo tubes. Nearly all the boats built by Schichau, of Elbing, Germany, are single screw, and this firm has built about half of the torpedo-boats of the world, but these boats have a bow rudder which may be raised or lowered at will, and which, when in operation, increases the manœuvring power very much. This device is equally important in many of our twin-screw boats, since the pivot, in turning, is almost at the fore foot, and turning is best accomplished by throwing the stern about with the screws. A bow rudder would shift the pivot to about midships, and improve the manœuvring power considerably.

As to bow torpedo tubes, we regard them as a folly, yet most of the boats of the world have them, and there is not, in Germany, a fighting vessel of any type, built or building, which does not have a bow tube either above or below the snout of the ram, below being the accepted position now.

As to the argument as regards single *vs.* twin screws, the former with bow rudders handle quite as well as the latter without, and it is claimed for the single screw that: (1) There is a great saving in oil with only one engine, and, when we consider that with two it takes about twenty-five gallons a day, this is important. (2) It takes fewer men to look out for one engine, the saving being at least two or three. (3) There are fewer moving parts, and, therefore, less chance of breakdown, while, at the same time, sufficient horse-power can be developed to give reasonable speed. (4) The weight and space of machinery is less, and greater strength can be afforded. After all, reliability of machinery is a matter of design, of material, and of high-class workman-

ship, and single screws have quite as much to commend them as twin, provided sufficient horse-power can be developed. One of the great drawbacks to single screws is that their draft of water is greater, especially for boats with a skeg, or keel support for the heel of rudder, although in some of the Thornycroft and Yarrow boats there are no supports for the rudder, and thus some inches of draft are saved.

As torpedo-boats abroad are frankly intended to manœuvre or cruise in groups, questions of spare parts, breakdowns, shortage in supplies, etc., are not so serious, since the boats rely on one another somewhat in cases of emergency. Probably no country has developed her torpedo-boat system so thoroughly as Germany. Fully 90 per cent of her boats were built by Schichau, and the custom is to order them in groups of eight, all practically of similar design and with interchangeable parts. The tonnage has gradually increased from 85 to 140 tons, as at present. Six of these boats form a group for manœuvring purposes, so that two of the eight are kept in reserve to take the place of any that may come to grief. There are ten large division, or "D" boats, of from 250 to 380 tons displacement, and from 1,800 to 5,500 horse-power. They are each a sort of flagship, or "mother" boat, for each group of six smaller ones, and accompany it everywhere. This division, or "D" boat, carries the heavier spare parts for the six accompanying boats, such as cylinder-heads, piston-rods, propellers, and a reserve supply of stores and fittings. Each "division" has its headquarters at a certain navy yard and has a group of small storehouses at the water front, one for each boat, including the "D" boat and the two in reserve. When a whole division is in the second reserve all the stores of each boat are in its own storehouse, and the group of boats is tied up near the group of storehouses. Any deficiencies in stores or fittings are made up from the large central torpedo storehouse, where all articles are standardized. In the winter the boats in reserve are kept at a uniform temperature by means of steam coils, connected with the shore by piping. Only when repairs are needed are boats hauled out, so that the division may always be ready to be put into commission for trials in 24 hours and ready for war in 48 hours. If in drills, or cruising, a boat is injured, it is astonishing to see how quickly a spare boat of the group is forthcoming, and ready with the crew of the injured boat. Boats in the second reserve are looked out for by the navy-yard force, and a vessel under repair is always in the second reserve.

As to boilers, the locomotive type has at last disappeared in newer boats. It retained its hold as long as it did through its adaptability for burning liquid fuel. The introduction of water-tube boilers has rendered it necessary to experiment somewhat as to the types best suited for burning petroleum refuse. In Germany they use, very largely, a German product called earth oil, unfitted for refinement, and they burn it on the Italian system (cuneberti), but principally as an auxiliary fuel for high speeds and for starting fires quickly. The Russian refuse oil is used in Italy, and it is stored in tanks at the principal dock-yards, there being on hand a large reserve for war. Practically, all of their torpedo-boats and fully thirty of their largest men-of-war use liquid fuel either entirely or as auxiliary to coal. In Russia experimenting goes on apace. Our country, of all others, might well adopt liquid fuel, although the purity of the ordinary petroleum and lack of residue makes it necessary to conduct experiments. Its evaporative efficiency as compared with coal is as 2.27 to 1. For the same storage capacity it adds 60 per cent to the radius of action of a boat; it can be delivered at sea from tank steamers in a few hours and in bad weather; it is absolutely free from danger of explosion and ignition, which coal is not; the amount used can be regulated accurately; forced draught does not require extra work on the part of any one; there is no need to transport fuel long distances as with coal; it prevents rust in bunkers; if a bunker is pierced the petroleum flows out only to the level of the water; it maintains steam more economically at anchor and in running slowly; the boiler does not choke; there are no ashes to hoist; it is easier on the boilers; it does away with coal passers; a water-tender can also fire; and above all it enables us to get steam quicker and to vary the pressure more easily at will. There is one thing to be considered, and that is that the compressed-air method of feeding commends itself in preference to the steam jet, because in the first place the air-compressing machinery must be in every boat anyway, and in the second place, the radius of action of a torpedo-boat is absolutely limited by her fresh-water supply, and not so much, as supposed, by fuel, although, of course, it takes fuel to distil water. It is in this question of fresh-water tanks and storage capacity that all these fancy yachts and phenomenal torpedo-boats prove failures for hard sea service.

One of the most important questions to be asked about a torpedo-boat outside of the motive power is as to the capacity of her distillers and tanks. Moderate, reliable sea speed coupled with large capacity for carrying and distilling fresh water is the fundamental requirement. Distilling ships to accompany ships operating from a distant base are a modern naval necessity. Fresh water represents time and coal, and is not so readily obtained as coal, at least as a commercial article. With liquid fuel, a navy will have to provide itself with tank steamers for both fuel and water, more especially if the method of burning it is by the use of steam spray or jet, but even using the compressed air spray the amount of water required to make up feed-water is astonishing.

All this suggests the question, "What are the desirable characteristics of a first-class sea-going torpedo-boat?" The answer here given is: (1) It should be as small as is consistent with seaworthiness, so as to offer as small a target and be as little visible as possible, and, at the same time, should offer a reasonably stable platform for its torpedo tubes. (2) It should be designed to have as small a bow wave as possible; its machinery should be as nearly noiseless as practicable; and it should not show flames or smoke from the stacks. (3) It should have a large fresh-water tank capacity and be fitted with two smaller evaporators and distillers in preference to one larger one. (4) It should have a reasonable bunker capacity. If for coal, the design should have in view the future use of liquid fuel. (5) The efficiency of the boat depending so largely upon the physical condition of the crew, habitability should receive due consideration in the design. (6) Speed is not essential, although desirable, but a moderate reliable sea speed, obtained without forcing and without noise, flame, and vibration should be striven for.

The use of liquid fuel best avoids the question of flames and smoke from the stack, and noisy machinery and bow waves are best avoided by moderate speed secured by reliable machinery and boilers of ample power normally. A speed of 22-23 knots on a maximum displacement of 110 tons is here suggested for sea-going torpedo-boats, and 45 tons for harbor-defense boats, or boats of the second class. We have in the *Morris* and the *Talbot*, built by the Herreshoffs, a near approach to the ideal boats of the first and second class. Boats above 110 tons are too large to go through the systems of canals in the interior waterway which connects New York with South Carolina. On the Pacific Coast, except about Puget Sound, all of the harbors are practically bar-bound in bad weather, and first-class torpedo-boats will not prove as desirable as second-class ones, which are intended only for local harbor defense. Since the coast is so remote from any possible enemy, even a torpedo-boat is a luxury, although a number of sea-going torpedo boats and destroyers will be required on the Pacific Coast for drill and training purposes, and in Puget Sound for service.

The foregoing table shows the principal characteristics of a certain number of sea-going torpedo-boats of several countries, selected to correspond to a displacement of about 100 tons, but not as representing the standard type, although it may reasonably be assumed that any given boat represents the best at a given date of building. The "approximate average" is, of course, somewhat misleading, but is suggestive. As regards twin *vs.* single screws, it does not prove much. Both the draft and speed of the *Morris* are greater than given officially, although draft up to a certain point is a matter of little importance, since it is unsafe to fire a torpedo in less than 30 ft. of water, owing to the possible initial dive. For canals 6 ft. is not too much. It is estimated that for a boat of about 110 tons displacement it will require about 1,550 horse-power to drive her 23 knots, and 3,100 horse-power for 30 knots; in other words, about twice as much. Of course a great deal depends upon the design of the boat.

FIRST-CLASS SEA-GOING TORPEDO-BOATS OF SEVERAL NAVIES.

Country.	Date.	Where or by whom built.	Length (ft.).	Beam (ft.).	Draught (ft.).	Displacement (tons).	I. H. P.	Number Screws.	Extreme speed (knots).	Complement.	Coal (tons).
Austria	'95	Yarrow	147.5	14.7	6	107	2200	1	24	26	30
Denmark	'93	Copenhagen	140	14.3	7	114	1300	1	22	24	25
France	'92	Gruville	147.5	14.5	5	114	1550	2	24	34	20
Germany	'92	Schichau	144.4	16.5	7	110	1500	1	24	24	30
Great Britain	'87	Yarrow	135	14	6	105	1540	1	23	21	30
Italy	'97	Italy	135	14	5.3	110	1600	2	25	20	30
Russia	'91	Russia	128	15.7	6.9	98	1250	1	21	13	17
United States	'96	Herreshoff	139	15	4.1	103	1750	2	22.5	26	28
Approximate average	'93		140	14.8	6.0	108	1560	1.4	23.2	23	24

Since 1893 the size of torpedo-boats has increased very considerably, as in France, where the latest type is 150 tons and 4,200 horse-power, with 30 knots speed; Germany, 140 tons displacement, 2,500 horse-power, and 25 knots; and Italy, 150 tons, 2,700 horse-power, and 25 knots.

Just before the war with Spain, the United States bought at Schichau's, Elbing, torpedo-boat No. 450, now called the *Somers*. She is a single-screw boat of 143 tons displacement, 1,700 horse power, and a speed of 23 knots, and was built, in 1893, on the same lines as a group of other boats for the German navy, but with a quadruple-expansion instead of a triple-expansion engine. As there was no advantage demonstrated in the departure from the standard triple-expansion type, the German government declined to purchase her, and she was later offered to us. I personally recommended her purchase on the ground that whether or not she could be gotten across in time to be of service in case of war, she was a model boat, in many respects, since she was fitted with all the articles so carefully and systematically standardized through all these years by the German navy, and there is not a detail in her that has not its lesson for us. Far from being a failure, as many believe who talk and never think, I personally conducted her trials, which were satisfactory, and would consider it an honor to command her.

In the torpedo-boat discussion last year the following remarks were made [Transactions, Vol. VI, p. 66] which so nearly represent the exact opposite of what is here advocated that they are worth quoting:—"I believe we are very far from the final results under the extreme speeds, and as to advocating a slower boat than our enemy has—why, it will undoubtedly place us in a hazardous position. * * * I believe there is plenty of ability in the country to develop men who can handle the more refined type of torpedo-boats, and I believe that it should be invited and should not be condemned any more than the use of the chronometer should. Without careful treatment it is certainly useless, and

the torpedo-boat is undoubtedly recognized as being a refined machine." There is a good deal of misconception in all this. A fleet operating on an enemy's coast has with it torpedo-boat destroyers. Their base is the fleet; their purpose, to hunt out and destroy the torpedo-boats of the enemy. To say that it is hazardous to have slower torpedo-boats than one's enemy is to imply that torpedo-boats attack torpedo-boats. The technical opinion is that torpedo-boats operate from a port as a base. If two hostile ports are adjacent, then it might mean something. Of course, a destroyer can overtake a torpedo-boat, or is designed to do so. In a heavy sea an 18-knot cruiser might overtake a 30-knot destroyer. As regards a torpedo-boat being a "refined machine," every effort should be made to get it out of that category. Of course, a torpedo-boat needs skillful and intelligent handling, but the cavalry does not use race horses, and high-stepping hackneys do not make good polo ponies.

In conclusion, let it be understood that real progress is just as admissible with standardized fittings as with chaos. We can also learn several lessons from recent events. The *Oregon* and the *Iowa* gave a beautiful object lesson when they cut loose from a base in New York and reached, the one San Francisco, Cal., and the other, Manila, P. I., without having to rely on any supplies other than those they had in the auxiliaries accompanying them. Lieutenant Commander W. W. Kimball, U. S. N., has proposed that we adopt for sea-going torpedo-boats a similar scheme; that a certain number of boats in a group have as a base a large depot steamer to carry coal, liquid fuel, oil, water, waste, compressed air, spare parts, medical officers, relief officers and men, stores, supplies, repair shops, etc. This will enable us to shift the base from point to point, and make a fewer number of torpedo-boats cover a wider stretch of coast. With such a long coast line as we have, we can never afford to have all the torpedo-boats required. This would mean sea-going torpedo-boats for coast defense, and second-class boats for harbor defense, which is technically correct. Torpedo-boat destroyers, operating from a fleet as a base, would accompany said fleet wherever required to assist in protecting it from attack by the torpedo-boats of the enemy; in other words, in operations on the enemy's own coast. This view of the use of destroyers and first and second-class torpedo-boats is in conformity with modern tactical and strategical ideas.

A 500 FT. LAKE STEAMER.—At the Lorain, O., shipyard the steel lake freight steamer *John W. Gates* was launched last month. The new vessel is one of the four steamers of about 8,000 tons carrying capacity, building on the Great Lakes for the A. B. Wolvin and American Steel and Wire Co.'s interests. Her dimensions are: Length over all, 500 ft.; beam, 52 ft., and depth, moulded, 30 ft. The vessel is very strongly constructed. Her water bottom is divided into thirteen water tight compartments, and the hold into six water tight compartments by cross bulkheads. She will be fitted with quadruple expansion engines, with cylinders 16 1-2 in., 25 1-2 in., 38 1-2 in. and 60 in. dia. and 40 in. stroke, supplied with steam by Babcock & Wilcox water tube boilers. A propeller 14 ft. dia. and 15 1-2 ft. pitch will be fitted.

WORK OF THE U. S. ARMY TRANSPORT SERVICE AT SAN FRANCISCO, CAL.

Now that the transporting of a large army from the British Isles to South Africa is a matter of widespread comment among those interested in maritime affairs, and the general public, it is well to recall our recent experiences in this particular branch of sea traffic. The transportation of 40,000 troops across the Pacific to the Philippine Islands by the United States Army Transport Service at San Francisco was no easy undertaking. It necessitated the conversion of many "raw" merchant vessels into up-to-date transports adapted to all the requirements of the department; but this work, undertaken with the supervision of Colonel Oscar F. Long, U. S. A., an old campaigner and field companion of the late General Henry Lawton, was carried out with such rapidity and thoroughness as to win high praise from the authorities at Washington for the engineering talent on the Pacific coast.

That so large an army of men could be sent to the front with so little embarrassment to the War Department, and with small loss to the Government in ships, machinery, and men, is a remarkable achievement considering the available facilities. The days of departing troops have now passed, the reorganized fighting forces having been reduced one hundred per cent., and consequently the demand for mechanical skilled labor has very greatly decreased. Nothing now remains for the western division of the service to accomplish but to keep the regular fleet of transports in good repair; most of the chartered ships have been released, and only those owned by the Government will be kept on the route between San Francisco and Manila.

This war experience was not without its effect on the engineering interests of the Pacific coast. When it became known that the War Department intended sending large reinforcements to the front, that a great fleet of ships would be employed, and that all the vessels would require considerable remodeling, the iron works of San Francisco commenced to improve their plants and arrange to compete for the work that was sure to be offered on the Pacific coast. Several of the larger plants were, of course, already prepared to do any line of mechanical work, but there were a number of smaller shops that had not the equipment necessary for turning out a first-class job. These plants were informed that entire impartiality would be observed and that their bids would be taken into consideration with those of the greater establishments. The result was the smaller shops were enlarged and received a fair proportion of the work, though the large works got most of the extensive contracts because of their better facilities.

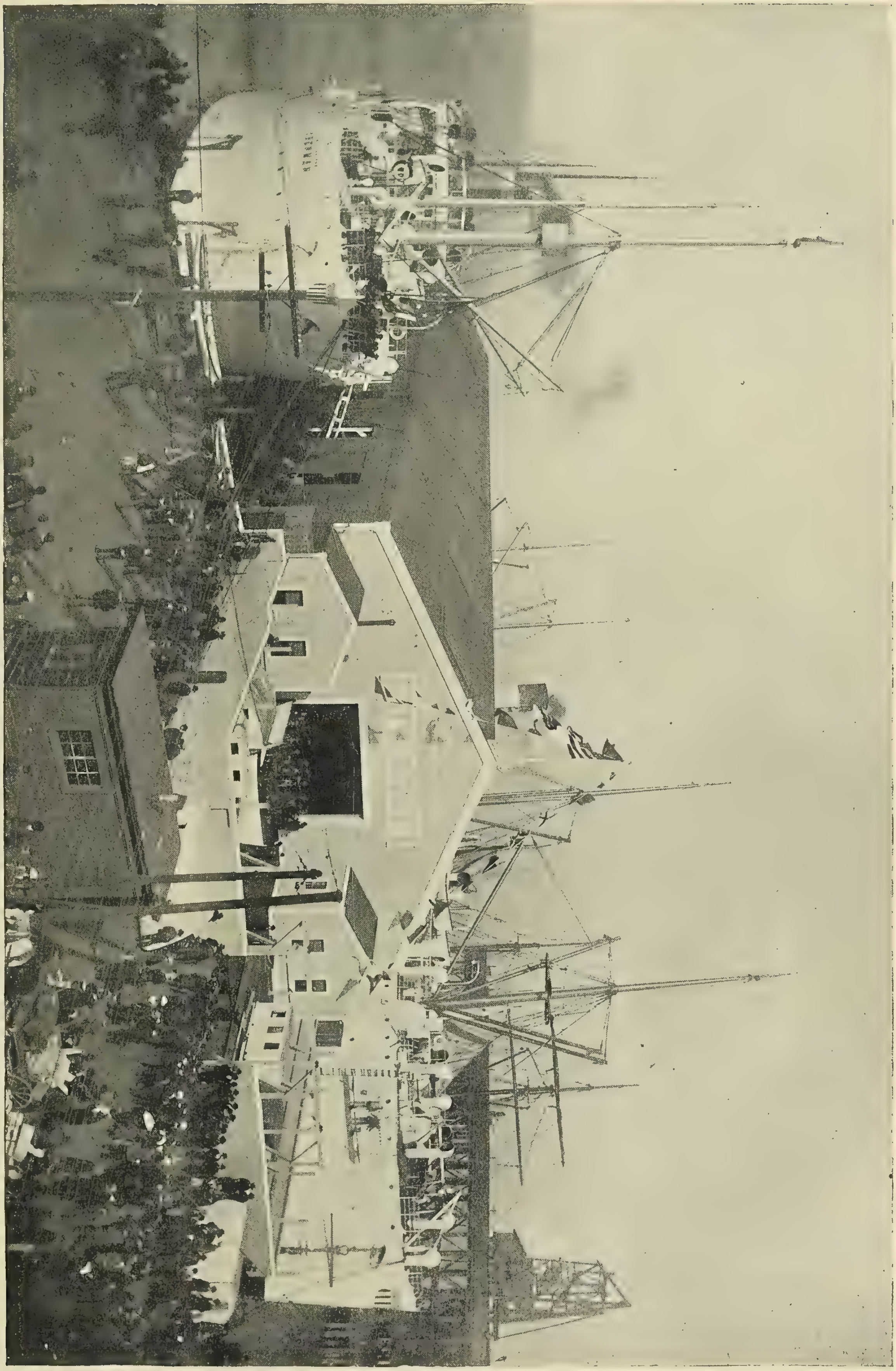
In order to realize what an undertaking the transport service was confronted with, it must be understood that the Government was without a sufficient number of steamers to draw upon in Pacific waters. The vessels secured were "raw" and engaged in the regular pursuits of commerce when spoken for. Many of the craft were without the ordinary equipment that might reasonably have been expected to be found on them. Operations were first commenced in May, 1898, and at that time there was not a steamer on the Pacific coast fitted for the transportation of men or stock to a port so dis-

tant as Manila. The ships of the Pacific Mail Steamship Company and the Oceanic Steamship Company, together with a couple of fast steamers belonging to the Pacific Coast Steamship Company, first attracted the attention of the Government officers. A number of these had been chartered to serve in the transporting of the volunteer army, but had been turned back, stripped of all the troopship fittings and made ready for regular commercial service again. The work of remodeling them had to be done all over again, and while the workmen were engaged on these pioneers of the "second call," messages were sent to the North and to the Orient querying owners of British tramps and American coasting craft.

By the middle of June Colonel Long was relieved to find that he had enough tonnage in sight, subject to charter or purchase, to carry 25,000 men. In the meantime the regular army transports, *Warren*, *Sheridan*, *Grant*, *Sherman*, *Hancock* and others, some of which were fitted out in Atlantic coast yards, were being counted on for immediate service. These ships had already voyaged to Manila and were in need of an extensive overhauling. It was decided to make the *Hancock* a particularly fine specimen of the American transport. Features of the equipment were a large refrigerating plant, with a capacity for storing enough meat to last 1,000 men four months; a soldier's kitchen provided with all kinds of appliances for steam cooking; an armory, magazines, and specie tank, all of large capacity. About $100,000 were expended in refitting the *Hancock*. Special care was taken with the finishing of the staterooms and officers' quarters, free use being made of burled red wood, selected pine and hardwood.

When a fleet of vessels had been secured for transport service attention was directed to the preparation of these vessels for their new service. A record was established by the discharging, repairing and reloading of eighteen vessels in as many days. The repairs to the fleet included not only general overhauling of the machinery, but the tearing out and rearranging of bulkheads, and the building of frames for bunks for an average of one thousand men to each ship. It was found that many of the ships hastily purchased by the Government were fitted with practically obsolete machinery. New boilers had to be furnished for some, and all required new deckhouses, lavatories for the men and shower baths, besides the regulation soldiers' kitchens. The same class of lavatories was placed on all the ships. They were modeled after those in use on the *Sherman*, *Sheridan* and *Grant*, and consisted of granite ware and porcelain basins with stop-cocks and openwork plumbing placed on tile floors. Patent closets were set in all the forward and after lavatory quarters. On deck a series of zinc troughs was set near the rails and connected with hot-water pipes. These sinks were intended for the washing of soldiers' dishes, and some for general cleansing purposes. Isolation hospitals were built in the after part of the ships or on top of the after deckhouses. These usually contained a ward and operating room and staterooms for the Red

ARRANGEMENT OF SOLDIERS' LAVATORIES IN U. S. TRANSPORTS FITTED OUT AT SAN FRANCISCO, CAL.



SAILING DAY AT THE U. S. ARMY TRANSPORT WHARF AT SAN FRANCISCO, CAL.—TRANSPORTS ABOUT TO LEAVE FOR THE PHILIPPINES WITH REINFORCEMENTS.

Cross corps. Storerooms were enlarged and extra lighting apparatus put in.

The transport service was confronted with a very serious situation when so many steamers were forced on the market for coal supplies. The dealers had not a sufficient supply on hand, and any sort of fuel had to be accepted that was offered. Next came the oil trouble. Certain oils were contracted for, and when examined it was found that much was unfit for use. It contained so much grit that it wore down the bearings of the machinery, necessitating the removal of the damaged parts on the return of the transports from their first trips out. The oil contracts were relet, and very little trouble was experienced with lubricants when special inspection was made of all oils delivered.

When so many vessels had to be selected from out of a comparatively small number of available ships it was not in every case possible to get them in a thoroughly satisfactory condition. When placed in service, however, few of the vessels behaved badly. Sensational newspaper reports concerning the condition of the transport *Manauense*, which arrived out after a perilous voyage, were widely published, in which it was made to appear that the vessel was unseaworthy when sent out as a transport. An inquiry into the circumstances connected with the taking over of the vessel for Government use showed that repairs made on it were not carried out by the Government, but by the owners of the vessel, who expended about $21,000 on the work. On receiving the vessel the transport officers had fitted it with bunks for the use of 450 men, and had also put in special fittings in the cabin and general quarters. The vessel had come from the Orient to San Francisco, and had made one coast trip before being put into service as a transport. She was chartered to the Government for $500 a day. The vessel was passed by the local U. S. Inspectors of Hulls and Boilers and by Lloyd's surveyor, and she was believed to be in good, seaworthy condition when she was sent to Manila with troops. It is believed in San Francisco that the trouble with the machinery of the vessel was probably due to negligence or incompetence in the operation of the vessel, and the story that she sprang a leak is discredited. In the opinion of the engineering staff of the transport service the chief cause of trouble was in the construction of the vessel. She is of the spar deck type, and between her poop and bridge houses there is a space sufficient to hold an immense quantity of water should a heavy sea be shipped. On her voyage out the vessel was caught in a typhoon and is supposed to have shipped a number of seas and been flooded, as her freeing ports were not of a sufficient capacity to carry off the water.

The *Manauense* is an old iron screw steamer built in 1874 at Port Glasgow, Scotland. Her dimensions are: Length, 281 ft.; beam, 32 ft.; depth, 23 ft.; gross tonnage, 1,672 tons. She is fitted with compound engines, with cylinders 41 in. and 71 in. by 42 in. stroke.

From May, 1898, to date the transport officers have handled 126 ships, almost all of which needed repairs of one sort or another. The engineering work was in charge of Superintending Engineer J. H. Matthews and his assistant, Mr. Humphries, working under the direction of Colonel Long in command of the service.

S. Y. Margarita for A. J. Drexel.

The accompanying drawings show the outlines and accommodations of the steam yacht *Margarita*, now building at the Scott Yard, Greenock, on the Clyde, for A. J. Drexel, of Philadelphia. The yacht is a Watson design, and is a large full-powered sea-going vessel of these dimensions: Length over all, 323 ft.; load water line, 272 ft.; beam, extreme, 36 ft. 7 in.; load draft, 16 ft. 8 in. She will have the usual clipper bow, overhung stern, two pole masts with a fore and aft sail spread and one funnel. She is flush decked, the side plating being carried up at the ends, with rail carried on stanchions along the sides of the main deck.

Steel is, of course, the material used for the construction of the hull and also of the decks, the latter being covered with teak. A double bottom is carried the entire length, and there are ten watertight compartments in all. There is a large amount of promenade space on the main deck, as the deck house is not continuous. Just aft of the foremast a small house contains the smoking room and spacious vestibule, with staircase communicating with the chart room and pilot house above and living rooms below. Abaft the funnel there is a spacious skylight or dome over the main dining room, and aft of this come the engine casing, and deck house, containing vestibule and boudoir, all of steel, paneled with teak wood.

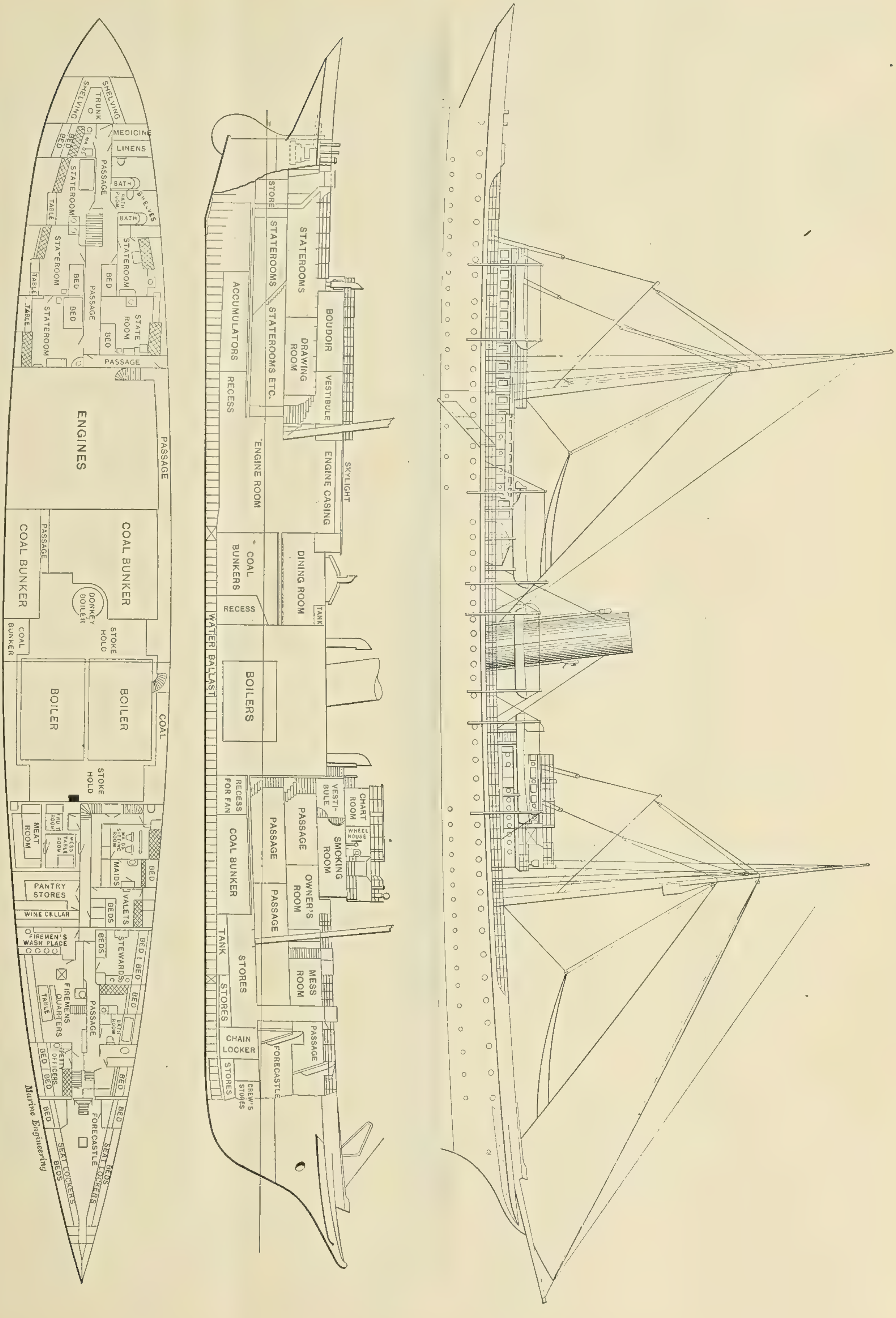
The *Margarita* will have twin screws, driven by triple expansion engines of about 5,000 I.H.P., designed to give a trial speed of 17 knots. Boilers will be of the cylindrical, multitubular type. The coal capacity figures out 550 tons, and there is large water capacity in the double bottom and tanks. A modern equipment of auxiliaries will be carried, including a refrigerating plant with a rated capacity of 1,200 lbs. of ice a day, electric lighting plant of 800 lights capacity, and an extensive system of mechanical ventilation.

As customary in vessels of this class, the scheme of decorating and finishing is very elaborate. The location of the various compartments is shown on the accompanying plans. The drawing room, which will extend the entire width of the ship, will be finished in Louis XV. style, the dining room in Chippendale, and the social hall or library in Empire style. In this room the wood work will be carved Spanish mahogany, with decorated stained glass dome. The smoking room in the forward main deck house will be treated in old English style, with oak paneling, and the boudoir in the after house will be finished in white wood. A rail will be carried around the top of the after house, and this space will be used as an observation platform by the guests. A feature of the equipment will be an armory supplied with rifle caliber automatic guns and small arms.

Eight boats will be supplied, including a steam and a naphtha launch. A crew of sixty-eight men all told will be carried.

It has been the intention to build a roomy, habitable boat in which long voyages can be undertaken in comfort.

A new coaching launch for Harvard to replace the *Frank Thompson* burned recently is to be built by Lawley & Son, of South Boston. The dimensions of the new boat will be: Length, 51 ft.; beam, 7 ft. 10 in., and draft, 3 ft.



SAIL AND ACCOMMODATION PLANS OF THE WATSON DESIGNED S. Y. MARGARITA BUILDING AT GREENOCK, SCOTLAND, FOR A. J. DREXEL, OF PHILADELPHIA.

REVIEW OF PAST PROGRESS IN STEAM NAVIGATION AND FORECAST OF FUTURE DEVELOPMENT.*—III.

BY SIR WILLIAM WHITE, CONSTRUCTOR-IN-CHIEF, R. N.

The earlier theories of resistance assumed that the resistance experienced by ships varied as the square of the speed. We now know that the frictional resistance of clean-painted surfaces of considerable length vary as the 1.83 power of the speed. This seems a small difference, but it is sensible in its effects, causing a reduction of 32 per cent at 10 knots, nearly 40 per cent at 20 knots, and 42 per cent at 25 knots. On the other hand, it is now known that the laws of variation of the residual or wave-making resistance may depart very widely from the law of the square of the speed, and it may be interesting to trace for the typical destroyer how the resistance actually varies.

Take first the total resistance. Up to 11 knots it varies nearly as the square of the speed; at 16 knots it has reached the cube; from 18 to 20 knots it varies as the 3.3 power. Then the index begins to diminish; at 22 knots it is 2.7; at 25 knots it has fallen to the square; and from thence to 30 knots it varies practically as does the frictional resistance. The residual resistance varies as the square of the speed up to 11 knots; as the cube, at 12 1-2 to 13 knots; as the fourth power, about 14 1-2 knots; and at a higher rate than the fifth power at 18 knots. Then the index begins to fall, reaching the square at 24 knots, and falling still lower at higher speeds. It will be seen, therefore, that when this small vessel has been driven up to 24 or 25 knots by a large relative expenditure of power, further increments of speed are obtained with less proportionate additions to the power.

Passing from the destroyer to the cruiser of similar form but of 14,100 tons, and once more applying the scale of comparison, it will be seen that to 25 knots in the destroyer corresponds a speed of 47 1-2 knots in the large vessel. In other words, the cruiser would not reach the condition where further increments of speed are obtained with comparatively moderate additions of power until she exceeded 47 knots, which is an impossible speed for such a vessel under existing conditions. The high speeds that could be reached by the cruiser with propelling apparatus of the lightest type yet fitted in large sea-going ships would correspond to speeds in the destroyer, for which the resistance is varying as the highest power of the speed. These are suggestive facts.

Frictional resistance, as is well known, is a most important matter in all classes of ships and at all speeds. Even in the typical destroyer this is so. At 12 knots the friction, with clean-painted bottom, represents 80 per cent of the total resistance; at 16 knots, 70 per cent; at 20 knots a little less than 50 per cent; and at 30 knots 45 per cent. If the coefficient of friction were doubled, and the maximum power developed with equal efficiency, a loss of speed of fully 4 knots would result. In the cruiser of similar form the friction represents 90 per cent at 12 knots, 85 per cent at 16 knots, nearly 80 per cent at 20 knots, and over 70 per cent at 23 knots. If the coefficient of friction were doubled at 23 knots, and the corresponding power developed with equal efficiency, the loss of speed would approximate to 4 knots. These illustrations only confirm general experience that clean bottoms are essential to economical propulsion and the maintenance of speed, and that frequent docking is necessary in vessels with bare iron or steel skins which foul in a comparatively short time.

POSSIBILITIES OF FURTHER INCREASE IN SPEED.

From the facts previously mentioned it is obvious that the increase in speed which has been effected is the result of many improvements, and has been accompanied by large additions to size, engine power, and cost. These facts do not discourage the inventor, who finds a favorite field of operation in schemes for attaining speeds of 50 to 60 knots at sea in vessels of moderate size. Sometimes the key to this remarkable advance is found in devices for reducing surface friction by the use of wonderful lubricants to be applied to the wetted surface of ships, or by interposing a layer of air between the skins of ships and the surrounding water, or other departures from ordinary practice. If these gentlemen would "condescend to figures" their estimates or guesses would be less sanguine. In many cases the proposals made would fail to produce any sensible reduction in resistance; in others it would increase resistance. Other proposals rest upon the idea that resistance may be largely reduced by adopting novel forms, departing widely from ordinary ship shapes.

Very often small-scale experiments, made in an unscientific and inaccurate manner, are adduced as proofs of the advantages claimed. In other instances mere assertion is thought sufficient. Ordinarily no regard is had to other considerations, such as internal capacity, structural weight and strength, stability, and seaworthiness. Most of these proposals do not merit serious consideration. Any which seem worth investigation can be dealt with simply and effectively by the method of model experiments. A striking example of this method will be found in the usual form of a parliamentary paper—No. 313 of 1873—containing a report made by William Froude to the Admiralty. Those interested in the subject will find therein much matter of special interest in connection with the conditions attending abnormally high speeds. It must suffice now to say that ship-shaped forms are not likely to be superseded at present.

The most prolific inventions are those connected with supposed improvements in propellers. One constantly meets with schemes guaranteed by the proposers to give largely increased efficiency and corresponding additions to speed. Variations in the numbers and forms of screws or paddles, the use of jets of water or air expelled by special apparatus through suitable openings, the employment of explosives, imitations of the fins of fishes, and numberless other departures from established practice, are constantly being proposed. As a rule the "inventors" have no intimate knowledge of the subject they treat, which is confessedly one of great difficulty. When experiments are adduced in support of proposals they are almost always found to be inconclusive and inaccurate. More or less mathematical dem-

*From a paper read before the British Association, Mechanical Science Section.

onstrations find favor with other inventors, but they are not more satisfactory than the experiments. An air of great precision commonly pervades the statements made as to possible increase in efficiency or speed. I have known cases where probable speeds with novel propellers have been estimated—or guessed—to the third place of decimals.

In one such instance a trial was made with the new propeller, with the result that, instead of a gain in efficiency, there was a serious loss of speed. Very few of the proposals made have merit enough to be subjected to trial. None of them can possibly give the benefits claimed. It need hardly be added that, in speaking thus of so-called "inventors," there is no suggestion that improvement has reached its limit, or that further discovery is not to be made. On the contrary, in regard to the forms of ships and propellers, continuous investigation is proceeding, and successive advances are being made. From the nature of the case, however, the difficulties to be surmounted increase as speeds rise; and a thorough mastery of the past history and present condition of the problems of steamship design and propulsion is required as a preparation for fruitful work in the nature of further advance.

It would be idle to attempt any predictions as to the characteristic features of ocean navigation sixty years hence. Radical changes may well be made within that period. Confining attention to the immediate future, it seems probable that the lines of advance which I have endeavored to indicate will remain in use. Further reductions may be anticipated in the weight of propelling apparatus and fuel in proportion to the power developed; further savings in the weight of the hulls, arising from the use of stronger materials and improved structural arrangements, improvements in form, and enlargement in dimensions. If greater drafts of water can be made possible, so much the better for carrying power and speed. For merchant vessels commercial considerations must govern the final decision; for warships the needs of naval warfare will prevail. It is certain that scientific methods of procedure and the use of model experiments on ships and propellers will become of increased importance. Already avenues for further progress are being opened. For example, the use of water-tube boilers in recent cruisers and battleships of the royal navy has resulted in saving one-third of the weight necessary with cylindrical boilers of the ordinary type to obtain the same power, with natural draft in the stokeholds.

Differences of opinion prevail as to the policy of adopting particular types of water-tube boilers; but the weight of opinion is distinctly in favor of some type of water-tube boiler in association with the high steam pressures now in use. Greater safety, quicker steam raising, and other advantages as well as economy of weight, can thus be secured. Some types of water-tube boilers would give greater saving in weight than the particular type used in the foregoing comparison with cylindrical boilers. Differences of opinion prevail also as to the upper limit of steam pressure which can with advantage be used, taking into account all the conditions in both engines and boilers. From the nature of the case, increases in pressure beyond the 160 lb. to 180 lb. per square inch commonly reached with cylindrical boilers cannot have anything like the same effect upon economy of fuel as the corresponding increases have had, starting from a lower pressure. Some authorities do not favor any excess above 250 lb. per square inch on the boilers, others would go as high as 300 lb., and some still higher.

Passing to the engine-rooms, the use of higher steam pressures and greater rates of revolution may and probably will produce reductions in weight compared with power. The use of stronger materials, improved designs, better balance of the moving parts, and close attention to details have tended in the same direction without sacrifice of strength. Necessarily there must be a sufficient margin to secure both strength and endurance in the motive power of steamships. Existing arrangements are the outgrowth of large experience, and new departures must be carefully scrutinized. The use of rotary engines, of which Mr. Parsons' turbo-motor is the leading example at present, gives the prospect of still further economies of weight. Mr. Parsons is disposed to think that he could about halve the weights now required for the engines, shafting and propellers of an Atlantic liner, while securing proper strength and durability. If this could be done in association with the use of water-tube boilers, it would effect a revolution in the design of this class of vessels, permitting higher speeds to be reached without exceeding the dimensions of existing ships.

It does not appear probable that, with coal as the fuel, water-tube boilers will surpass in economy the cylindrical boilers now in use; and skilled stoking seems essential if water-tube boilers are to be equal to the other type in rate of coal consumption. The general principle holds good that as more perfect mechanical appliances are introduced, so more skilled and disciplined management is required in order that the full benefits may be obtained. In all steamship performance the "human factor" is of great importance, but its importance increases as the appliances become more complex. In engine-rooms the fact has been recognized and the want met. There is no reason why it should not be similarly dealt with in the boiler-rooms.

Liquid fuel is already substituted for coal in many steamships. When sufficient quantities can be obtained it has many obvious advantages over coal, reducing greatly manual labor in embarking supplies, conveying it to the boilers, and using it as fuel. Possibly its advocates have claimed for it greater economical advantages over coal than can be supported by the results of extended experiment. Even if the saving in weight for equal evaporation is put as low as 30 per cent of the corresponding weight of coal, it would amount to 1,000 tons on a first-class Atlantic liner. This saving might be utilized in greater power and higher speed or in increased load. There would be a substantial saving on the stokehold staff. At present it does not appear that adequate supplies of liquid fuel are available. Competent authorities here and abroad are giving attention to this question, and to the development of supplies. If the want can be met at prices justifying the use of liquid fuel, there will undoubtedly be a movement in that direction.

Stronger materials for the construction of hulls are already available. They are, however, as yet but little used, except for special classes of vessels. Mild steel has taken the place of iron, and effected considerable

savings of weight. Alloys of steel with nickel and other metals are now made, which give strength and rigidity much superior to mild steel, in association with ample ductility. For destroyers and torpedo boats this stronger material is now largely used. It has also been adopted for certain important parts of the structures of recent ships in the royal navy. Of course, the stronger material is more costly, but its use enables sensible economies of weight to be made. It has been estimated, for example, that in an Atlantic liner of 20 knots average speed about 1,000 tons could be saved by using nickel steel instead of mild steel. This saving would suffice to raise the average speed more than a knot, without varying the dimensions of the ship. Alloys of aluminium have also been used for the hulls or portions of the hulls of yachts, torpedo boats, and small vessels. Considerable savings in weight have thus been effected. On the other hand, these alloys have been seriously corroded when exposed to the action of the sea water, and on that account are not likely to be extensively used. Other alloys will probably be found which will be free from this defect, and yet unite lightness with strength to a remarkable degree. Other examples might be given of the fact that the metallurgist has by no means exhausted his resources, and that the shipbuilder may look to him for continued help in the struggle to reduce the weights of floating structures.

It is unnecessary to amplify what has already been said as to possible increase in the efficiency and types of propellers. With limited draft, as speeds increase and greater powers have to be utilized. multiple propellers will probably come into use. Mr. Parsons has shown how such problems may be dealt with; and other investigators have done valuable work in the same direction. In view of what has happened, and is still happening, it is practically certain that the dimensions of steamships have not yet attained a maximum. Thanks to mechanical appliances, the largest ships built, or to be built, can be readily steered and worked. In this particular difficulties have diminished in recent years notwithstanding the growth in dimensions. Increase in length and weight favors the better maintenance of speed at sea. The tendency, therefore, will be to even greater regularity of service than at present. Quicker passages will to some extent diminish risks, and the chance of breakdown will be lessened if multiple propellers are used. Even now, with twin screws, the risk of total breakdown is extremely small.

Whatever may be the size and power of steamships there must come times at sea when they must slow down and wait for better weather. But the larger and longer the vessel the fewer will be the occasions when this precaution need be exercised. It must never be forgotten that as ships grow in size, speed, and cost, so the responsibilities of those in charge increase. The captain of a modern steamship needs remarkable qualities to perform his multifarious duties efficiently. The chief engineer must have great powers of organization as well as good technical knowledge, to control and utilize most advantageously the men and machinery in his charge. Apart from the ceaseless care, watchfulness and skill of officers and men, the finest ships and most perfect machinery are of little avail. The "human factor" is often forgotten, but is all-important. Let us hope that in the future as in the past, as responsibilities increase so will the men be found to bear them.

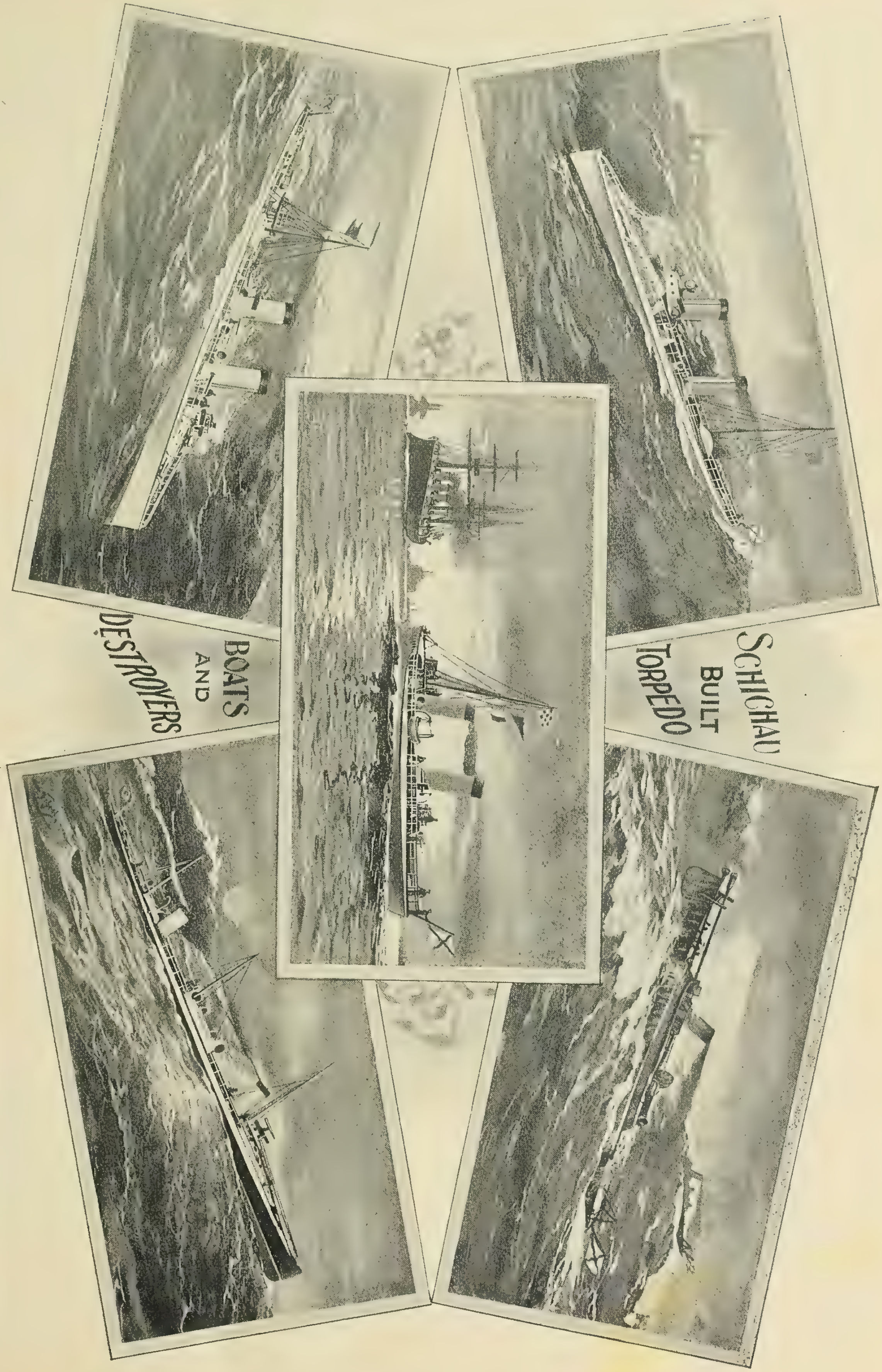
Schichau Torpedo Boats.

Among the foreign builders of vessels of the torpedo classes, F. Schichau of Elbing, West Prussia, has a high standing and reputation. His first boat was built for the Russian Government in 1877, and was a small affair with a speed of 16 knots. Since that time this German builder has turned out a very large number of vessels, not only for the Navy of his own country, but for the Governments of Russia, Italy, Austria, Norway, Sweden, Turkey, China, Japan and Brazil. We print herewith a typical group of vessels by this builder, ranging from a small torpedo boat for the Russian Government to the large full-powered destroyers which he recently turned out for China. The originals of these views are by one of the most famous German marine painters, and are made from actual sketches, showing the behavior of these small craft in various seas. In our issue of March, 1899, we published particulars of one of the new Schichau destroyers built for China, for which a trial speed (light) in excess of 35 knots was claimed. This speed, too, was secured with the use of reciprocating engines. In our own navy we have one Schichau vessel, the torpedo boat *Somers*. She is a single screw boat of 143 tons displacement, and quadruple expansion engines of 1,700 horse power, and has a maximum speed of 23 knots. Her boiler is of the now abandoned marine locomotive type. This boat was purchased during the Spanish war.

Annual Report.—The annual report of the Secretary of the Treasury shows that the work performed by vessels of the Revenue Cutter Service during the year, aside from participation in naval operations during the Spanish war, included the following: Miles cruised, 239,061; lives saved from drowning, 18; vessels boarded and papers examined, 18,039; vessels seized and reported for violations of law, 142; fines and penalties incurred by vessels reported, 28,970; vessels in distress, 111; value of vessels assisted and their cargoes, $1,735,762; persons on board vessels assisted, 946; persons in distress taken on board and cared for, 62. Two new vessels for the service will soon be contracted for, one for the Great Lakes and the other for the Pacific coast. It is again recommended that several of the old cutters be sold out of the service and that as many new vessels be built to replace them.

U. S. Foreign Commerce.—For the fiscal year ending June 30, 1899, the foreign commerce of the United States reached a total of $1,924,171,000. This includes all exports and imports, other than gold and silver. Of this total, New York got the largest share, the imports amounting to $465,559,650 and exports $459,444,217. Boston comes next, with imports footing up $52,097,960 and exports $128,037,149. Of the other cities only Baltimore and Philadelphia transacted a business in excess of $100,000,000 during the year.

New Revenue Cutter.—Designs for a new revenue cutter for the Great Lakes have been prepared by the engineering staff of the service. The new vessel is to be of these dimensions: Length, 178 ft.; beam, 30 ft.; depth, 15 ft. She will be fitted with triple expansion engines with cylinders 17 in., 27 in. and 43 in. dia. and 24 in. stroke. Steam will be generated in two single ended cylindrical boilers at a working pressure of 160 lb. The new vessel will be built of steel and will cost about $165,000.



SKETCHES OF SCHICHAU BUILT TORPEDO BOATS AND DESTROYERS BUILT FOR RUSSIAN, CHINESE AND BRAZILIAN NAVIES, DRAWN BY HANS BOHRDT FROM STUDIES MADE AT SEA.

COMPARISON BETWEEN PERFORMANCES OF TWO SEA-GOING STEAMSHIPS.*—III.

BY J. D. M'ARTHUR, MEMBER.

With regard to the distribution of power in the cylinders, B was at a great disadvantage compared with A, for while in the latter the division of work was fairly uniform, in B the opposite obtained, the L.P. engine developing power fully 30 per cent, and the L.P. also, in excess of the H.P.

This was partly original sin, considerably augmented, however, by the bad state of the H.P. cylinder barrel and piston. The former tapered 1-8 in. between the top and bottom, the larger diameter being 24 7-16 in., or 7-16 in. greater than the original size, and this after barely four years' running. The barrel was separate from the cylinder, but appeared to have been cast of sole-plate metal, softer if anything, and chipping ridges off was a constant job.

Originally the H.P. piston had a flat junk-ring, and a floating or bull ring, fitted with Ramsbottom springs, 3-4 in. square section; but on her first voyage one of the junk-ring bolts worked back, breaking the junk-ring and bending the rod. The new ring supplied had the bull-ring cast in one piece with it, Ramsbottom springs being still adhered to. During a subsequent voyage, another junk-ring bolt was thrown out, this time, however, incredible as it may seem, without doing any damage. The ship at the time was within a few hours of port, on a lee shore, with a strong breeze blowing. After arrival the casing cover was lifted, and the bolt found in two pieces, having been cut by the piston valve as clean as if done in a shearing machine. The clearance spaces in all the cylinders were large, and those above the pistons were increased by the amount the engines were down. This fact probably saved the cylinder cover from being knocked off or the piston rod from again being bent, for the bolt (1 1-4 in. diameter) must have slacked well back out of the nut first, and then jumped clear of the hole on the down stroke, lain flat on the piston, and been carried by the exhausting steam through the port to the piston valve, which sheared it through on its up-stroke when closing the port to exhaust, a slight indentation on the edges of the valve and port being the only visible damage.

Even when the springs were new, however, and the piston in a fairly tight condition, the power developed in the I.P. engine preponderated, although the L.P. expansion was shut well in, showing clearly that the valve and the pulleys required alteration. Expansion blocks were without grades or marks of any description, so the only guide to the position of cut-off was the indicator card, and time in port abroad was too fully occupied in carrying on the necessary work to have any to devote to valve-setting.

As has been already mentioned, both the steering and fan engines received steam at full boiler pressure. The valves of steering engines, in order to permit of reversal with a single fixed eccentric, possess neither lap nor lead, and so these engines are extremely wasteful of steam, both with regard to the quantity required to drive them and through leakage past the valves. Working under such a high pressure as 160 lbs., and exhausting to the condenser at practically that same pressure, the loss of heat is all the greater, leaving out of account the increased difficulty of keeping the glands tight, and the loss thereat. The case of the fan engine is, perhaps, not so bad, but still a more economical result might be attained by the use of steam reduced to 80 lb., or thereabouts. If instead of exhausting into the condenser, these engines, or others similarly wrought, were arranged so that their exhausts could be turned into the L.P. casing when at sea, the effect would probably be beneficial—first, by slightly increasing the pressure; and, secondly, by surrendering their excess of heat, and so diminishing condensation in the casing, thus increasing the power of the L.P. engine in two ways, without increasing the back pressure on the pistons to any great extent by reason of the bends and length of piping.

The condenser itself was a conspicuous source of loss, but the fault in this case lay not so much with the design as the management at sea; although, so far as could be learned, the vacuum was from the first more or less bad. An attempt to reduce the wearing and scoring of the H.P. cylinder by a lavish application of oil soon made its effects felt both in the condenser and boilers. It would appear that engine-oil had been used to make the valve-oil spin out, its probable effect on the boilers never being taken into account till corrosion obtained a good hold, particularly of the lower parts of combustion chambers, lower water-space stays and steam-space stays. One or two of the combustion chamber back plates also showed signs of buckling, and the dirt which caused this very probably owed some part of its non-conducting quality to the presence of grease. After the use of oil was discontinued the corrosion in a great measure ceased, but having once got a hold in places where the plates and stays cannot be scraped thoroughly clean, its progress is still manifest in spite of a liberal distribution of zinc plates over the worst affected spots, and the daily injection of soda.

The ratio of heating surface in the boilers to cooling surface in the condenser was as two to one, and at the power usually developed there were 2 sq. ft of cooling surface per I.H.P. The air-pump being also of ample size, and in fairly good order, there was no apparent reason why the vacuum should not have been originally good, but to such an extent had grease accumulated on the outside of the tubes, and scale on the water side, that in water of the temperature of 78 deg. to 80 deg., only 17 in. of vacuum was obtainable, the temperature of the hot well being 185 deg., and the discharge water 110 deg. The high temperature of the hot well necessitated the vapor from the evaporator being discharged into the condensor, which, besides further impairing the vacuum, greatly enhanced the cost of the fresh water. This result was achieved in less than four years, during the regime of three chief engineers, without apparently exciting much comment.

From what has been already mentioned of the prevalence of dust in the engine-room, it will hardly be necessary to say that the wear and tear of bearings, etc., in B was much greater than in A, the common

* Read before the Institute of Marine Engineers, London, England.

rate of wear of the guide-shoes, for instance, being about 1-8 in. in six months, more, rather than less; this, of course, did not help the packing in any way, and on a long run meant stopping and lining up.

Several other features of the general arrangement afforded scope for improvement, but as they have no bearing on the economical aspect of the question, they may be left out of account, so that the only points remaining which call for comment are the propellers and design of the hulls. Both ships were provided with propellers of the ordinary four-bladed type, A's being 18 ft. 6 in. dia. and 18 ft. pitch; B's 16 ft. 6 in. dia. and 17 ft. 6 in. pitch, the pitch being uniform in both cases, and blades of steel. In smooth water, at ordinary speed, the apparent slip of A's propeller was about 6 per cent, and during a voyage, in which no very strong or incessant head-winds were encountered, it did not, as a rule, much exceed 11 to 12 per cent, the ship possessing a fairly easy entrance and good run. On the other hand, in B, model was entirely sacrificed to carrying capacity, the entrance being very bluff, the run and under-water body very full. The actual values of the co-efficients of displacement and circumscribing rectangle are unknown to the author, but, judging from appearance, these must have been pretty close to the highest found in ordinary practice, and were unmistakably greater than those of A. With bottom freshly painted, and just out of dry dock, in smooth water, the slip of B's propeller was not less than 10 or 11 per cent, and it rose very quickly with even a moderate head-wind or swell, showing that to a great extent the bluffness of form brought about a loss of performance not at all compensated for by the slightly additional percentage of carrying power so gained. In conclusion, it may be noted that, while A was a stiff ship, and a heavy roller in a sea-way, B was crank, but an excellent sea boat. Loaded full to the hatches, with a homogeneous cargo of sufficient weight to submerge her to the ordinary draught, the metacentric height must have been very small, practically nil for small angles of heel, although at greater angles it was evidently sufficient, and the range of stability good enough. It was almost an impossibility to keep her on an even keel, however, and it only required a moderate breeze on the beam to list her over 3 deg. or 4 deg., where she would lie until either the wind came off the other side, or sufficient coal had been worked off the low side to bring her up. She had more tumble-home in her sides than is usual nowadays, and this, by reducing the beam at the load water-line, together with the fullness of her under-water form, and consequently greater displacement, would assist in lowering the metacenter, but that point will be left open for the opinion of those better acquainted with the subject. She was fitted with bilge keels, or rolling chocks, and that these materially help to steady a ship can be realized by anyone who has watched the surging and boiling of the water caused by them as the ship rolls in a heavy sea. To these, and the fact of her being tender, the safety of the ship and lives on board of her may be ascribed; for had she been a heavy roller in the weather and under the conditions experienced not long ago, this paper would probably never have been written.

Stated briefly, in order to be readily seen for discussion, the various advantages, or supposed advantages, of A over B may be grouped together as follows: (1) Equal distribution of power between the cylinders. (2) Use of a slide valve in H.P. cylinder, as compared with a block piston-valve, and greater steam-tightness of valve and piston. (3) Increased temperature of feed, and saving by Weir's system of feed-heating. (4) Use of steam in auxiliary engine at press. of 80 lbs., reduced from 160 lbs. (5) Difference in arrangement of dead-plates, and smaller area of funnel per square foot of grate. (6) Improved wear of bearings, guide-faces, etc., with corresponding less friction and loss at glands. This, of course, had the effect, outside of the question of fuel, of a diminished expenditure on up-keep, to such an extent that B's bill at the end of four years for tear and wear was many times greater than A's. (7) Cooler stokehold, enabling steam to be kept steadier, and greater attention paid to correct stoking during at least part of a voyage. (8) Better vacuum. In taking B's consumption at 1.7 lb per I.H.P., vacuum is equivalent to 23 in. with sea water of 55 deg. (9) Smaller co-efficient of fineness and smaller percentage slip of propeller. This, while not affecting the lbs. per I.H.P., has a direct bearing on the consumption per ton per mile, which is the more important aspect from the ship-owner's point of view.

The author regrets that, while in the main the figures given in this paper are correct, so far as known, he cannot vouch for the accuracy of them all, as through notes becoming mislaid they had to be supplied from memory; also, that no indicator cards can be produced, as they were destroyed by water. Such items as lb. per I.H.P., and consumption per ton per mile, are closely approximate to the actual conditions of working, and the differences between them can be readily seen.

Lake Side Wheel Steamer Tashmoo.

A fine new fast passenger vessel for service on the Great Lakes between Detroit and Port Huron was launched from the yard of the Detroit Shipbuilding Company December 30 last. She is named the *Tashmoo*, and will run under the flag of the White Star Line of the lakes. A general idea of the appearance of the new vessel when at sea can be had from the accompanying drawing. She is not unlike vessels on the Sound service running out of New York.

The *Tashmoo* is the largest and most costly vessel ever built for the service. Her general dimensions are: Length, overall, 315 ft.; on load water line, 301 ft.; beam of hull, 37 ft. 6 in.; overall, 70 ft.; depth, 13 ft. 6 in. Accommodation for 2,500 passengers is arranged for. In the group of photographs those of the hull give a suggestion of her fine lines, the vessel having been designed for high speed. An innovation is the balanced rudder plainly seen in the view from astern. The hull is of mild steel, and is divided into six compartments by five watertight bulkheads. As the drawing shows, the vessel is a side-wheeler, with feathering paddles, 22 ft. 4 in. dia., 12 ft. face, each having 9 floats 4 ft. wide. The wheels will be driven by a set of inclined triple expansion direct connected engines, with cylinders 33 in., 51 in., and 82 in. dia. and 6 ft. stroke. Two views of these engines while being assembled in the erecting shop are here given, and show their size and the workman-like character of design. The H. P.

cylinder is placed between the I. P. and L. P. cylinders, and is fitted with a piston valve. Both the other cylinders have double-ported slide valves, and will be handled by direct steam reversing engine. An injection condenser is fitted, the vessel being built for freshwater service, and the air pump will be worked by levers from the H. P. crosshead. By an arrangement of suitable valves and tanks the discharge water can be used for trimming the vessel when required.

Steam will be furnished by two double ended and three single ended boilers of the cylindrical fire-tube type, each 11 ft. 1 in. dia. There will be a total of fourteen furnaces, each 44 in. dia., and the uptakes will be connected to two stacks 6 ft. 9 in. dia., and 60 ft. high above the grates.

Much care has been taken with the finishing of the interior and scheme of decoration. On the main deck the saloon and lobby will be finished in quartered oak and the café in mahogany. Mahogany will also be used in finishing the saloon on the promenade deck. At the sides five parlors are arranged, with bay windows, each room being finished and furnished in a different style. A smoking room is located forward on the upper deck.

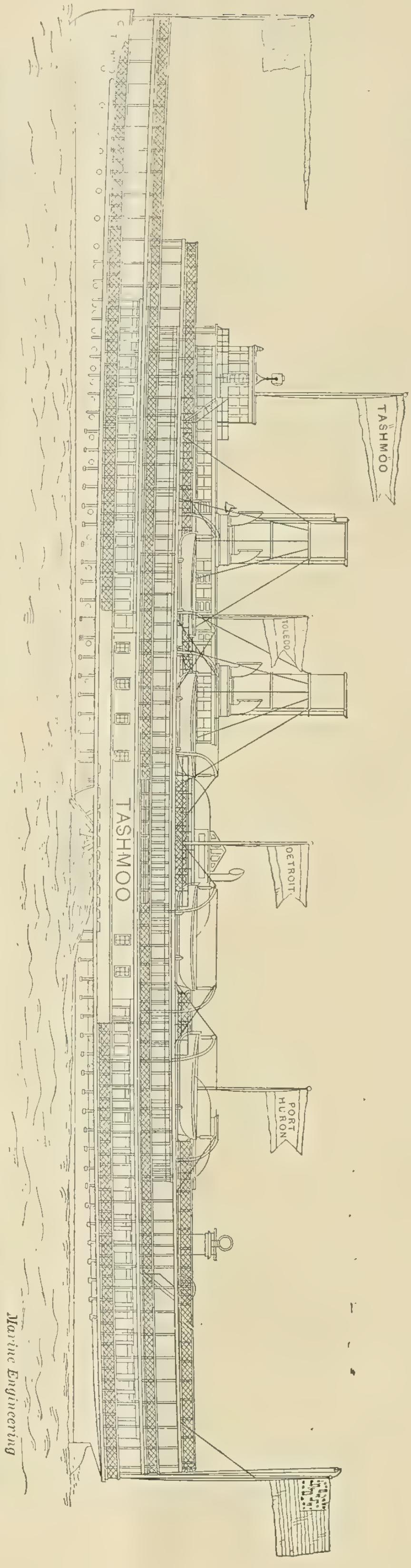
For handling the vessel a complete instalment of machinery will be fitted, including steam capstans, steam steerer and the usual equipment of boats and rafts required by law will be carried.

This fine vessel was designed by Frank E. Kirby, and she is expected to be ready for service in June.

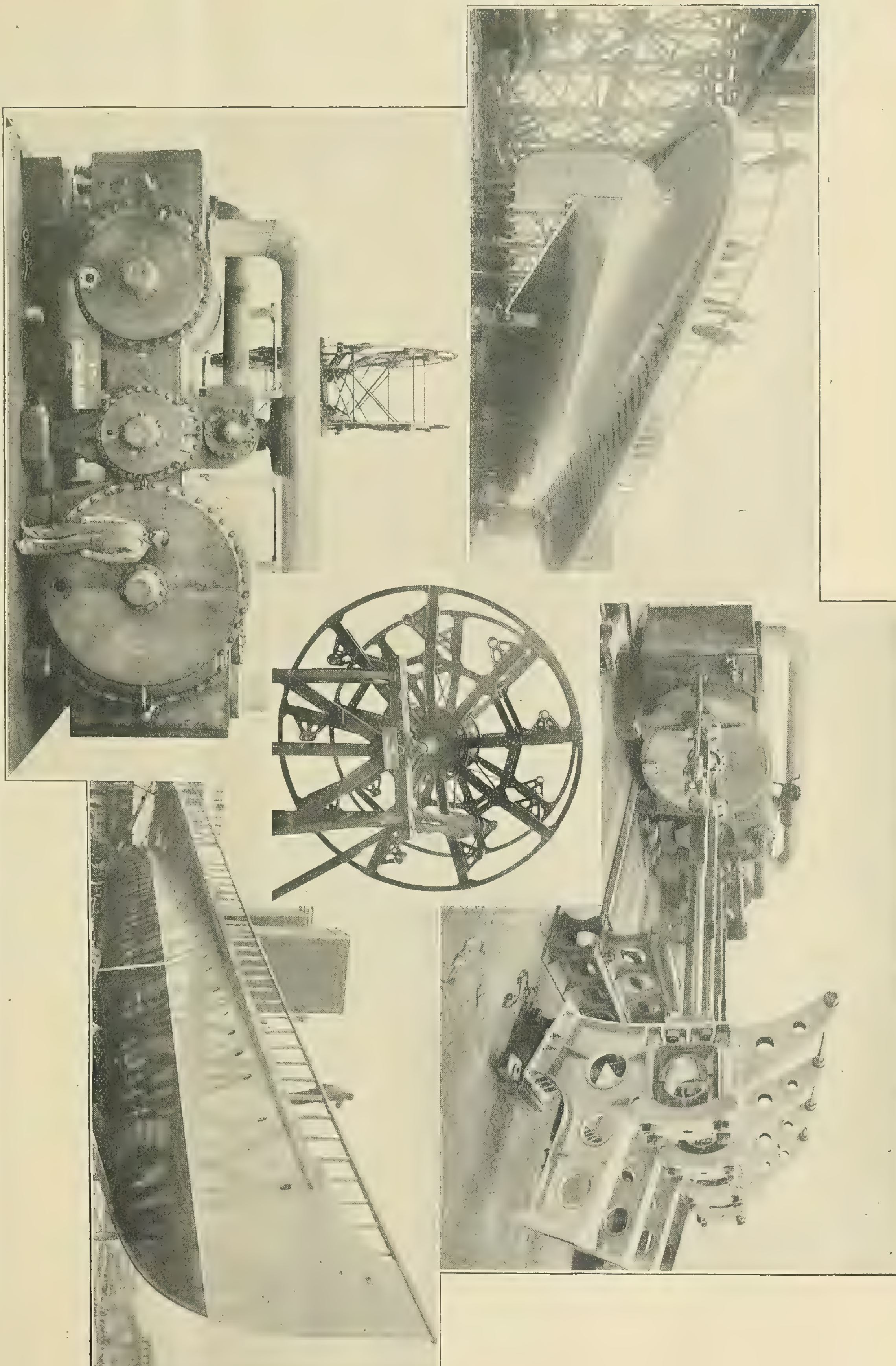
Transport Mishaps.—The transfer of so large an army from the British Isles to South Africa during the present campaign has not been carried out without some disaster, but though there has been a large loss of property and war material there has, curiously enough, been no attendant loss of life. The mishaps commenced with the loss of about 250 horses, through heavy seas on the S.S. *Rapidan* bound out from Liverpool, before she had cleared the Irish coast. The *Ismore*, a new vessel of 5,000 gross tons, was wrecked at the Cape of Good Hope, with detachments of various corps, 250 horses, and valuable stores on board. A loss nearer home was that of the collier *Maltby*, which stranded when leaving the mouth of the river Tyne on the East coast of England and became a total loss. Another large steamer, the *Denton Grange* touched bottom at Las Palmas, Canary Islands, and is now the subject of salvage operations.

Chicago Drainage Canal.—Water was recently let into the Chicago drainage canal which now gives a waterway for deep draft vessels from the Chicago river to Lockport, Ill. Co-operation of various commercial bodies is now being sought to get a Congressional appropriation for the purpose of extending the ship canal from Lockport to the Illinois river, and thence to the Mississippi river, so that vessels drawing not more than 16 ft. could pass from the Great Lakes to the Gulf of Mexico. It is estimated that this extension would cost about $25,000,000.

Transfer of the ownership of the S.S. *Brasilia*, 10,000 gross tons, from the Hamburg-American line to the Dominion line flag is reported.



STEEL SIDE WHEEL PASSENGER STEAMER TASHMOO FOR THE WHITE STAR LINE OF THE GREAT LAKES—LENGTH 315 FT., I. H. P. 3,000—BUILDING AT DETROIT, MICH.



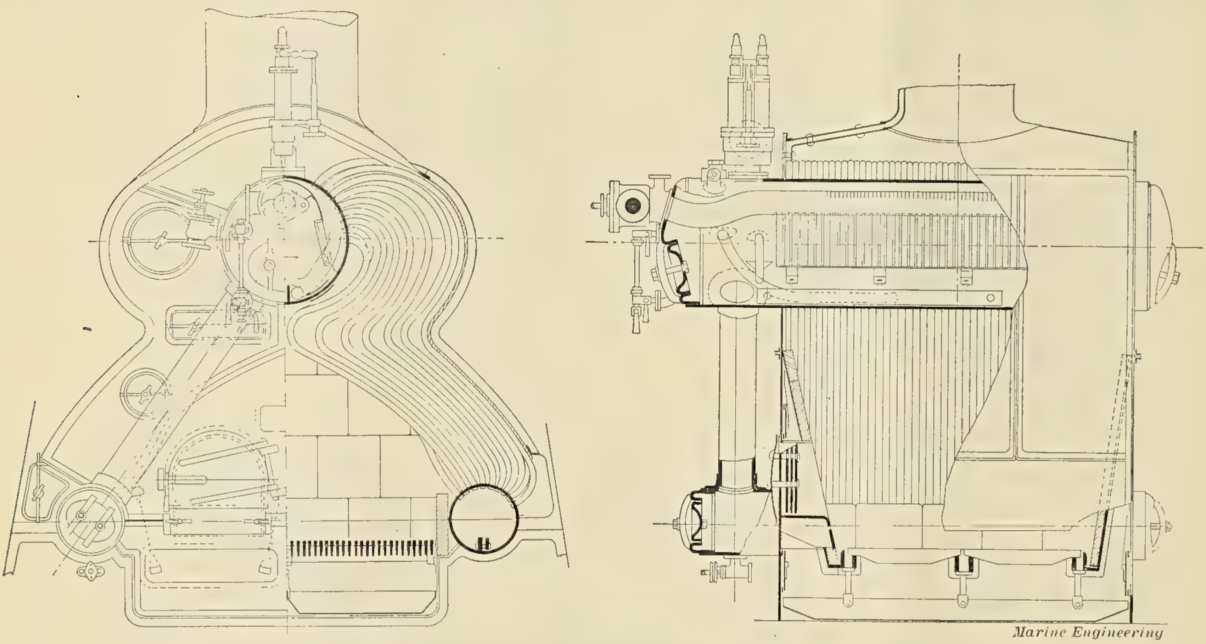
HULL OF THE LAKE SIDE WHEEL STEAMER TASHMOO ON THE BLOCKS; ALSO ENGINES IN COURSE OF ERECTION AND ONE FEATHERING WHEEL, IN DETROIT SHIPYARD.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—II.

DESCRIPTIONS OF THORNYCROFT, TAYLOR AND ROBERTS BOILERS WITH SECTIONAL DRAWINGS.

Thornycroft Water-tube Boiler.

This boiler is of the small bent tube type, without screwed joints or connections in contact with the fire. It has generally been built with the tubes discharging above the water level into the top drum. The original or "Speedy" type of this boiler is shown in the drawings published herewith, and it is probably most generally known. In this there is a central steam and water drum situated over the furnace, and connected by bent tubes to two lower drums at the bottom, one on each side, at about the level of the grate. Each tube is in one continuous length and is expanded in place, the drums being of sufficient thickness where the tubes enter to ensure absolute tightness. The tubes nearer the furnace are brought together to form practically a solid wall, except at the lower ends, where they are staggered to permit of the upward flow of gases, while the outer rows are arranged to form a wall, except at the extreme upper ends, where the gases pass through to the smoke pipe. By this placing of the tubes in a series of walls the gases are made to pass among all the small tubes and give up their heat on the way from the grate to the stack. At the upper ends it will be noticed the tubes are curved so that all enter the drum above the water level; therefore, when the boiler is filled ready for steaming and the fire is lit, the heat passing over all the small tubes causes a very rapid upward circulation of water, portion of which is converted into steam. The return of the water to the lower side drums is effected by two water tubes of large diameter fitted at one end of the boiler outside the casing. The mixture of water and steam, carried up through the small tubes, is discharged against a baffle plate in the upper drum, while the steam is carried off by the dry pipe situated underneath the crown of the baffle plate. For purposes of inspection and repair easy access is had to the interior of the drums through manholes in the ends. A modification of this form of boiler styled the "Daring" type is also regularly built where a much larger unit is desired. This consists, in general, of one large upper steam and water drum, a lower and smaller central drum, and two still smaller outside drums. There are two grates, situated between the lower central and outside drums. All the drums are connected by vertical down take pipes of large diameter, and the generating tubes are of small diameter, arranged substantially the same as those in the "Speedy" type. The Thornycroft boiler is named after the torpedo craft builders, John I. Thornycroft & Co., of London, by whom it was designed and installed in a very large number of high speed vessels. In this country the boiler is controlled by Thorpe, Platt & Co., 97-99 Cedar St., New York. In Government work here extensive use has been made of the Thornycroft boiler, hitherto in smaller vessels; but at the present time there are several installations of this type planned for large war vessels, including the battleships *Ohio* and *Missouri*. The total built or building for the U. S. Government on both the Atlantic and Pacific coasts is about 200,000 horse power.



SECTIONAL ELEVATIONS OF THE THORNYCROFT WATER TUBE BOILER.

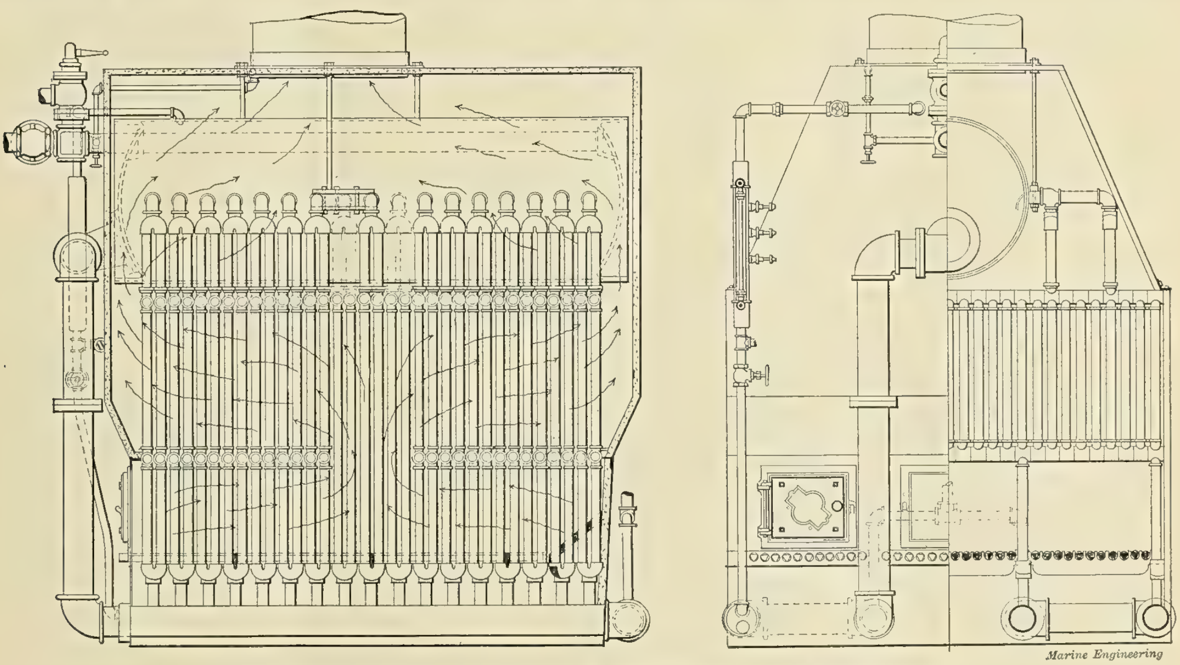
Taylor Water-Tube Boiler.

Though of the small tube type this boiler differs very much in construction from others which have screwed connections throughout. All the generating tubes are vertical except for the short lengths at the upper ends, where some of the tubes are carried horizontally in a row on each side into the drum at about the water level.

It is also termed a "sectional" boiler, for the reason that it is built up of sections of tubes rather than of separate tubes, and this is made the claim for ease of repair, which will be referred to later. In general the boiler consists of a large number of short straight vertical water tubes over the fire, connected with headers, which in turn are connected with manifolds at the bottom and a steam and water drum extending lengthwise of the boiler at the top. As shown in the accompanying drawings, there are four large bottom manifolds reaching from front to rear of the boiler at some distance below the grate. From these two or four downflow pipes arise outside the casing (back and front) and connect with the drum below the water line. Connection is also made with the bottom manifolds by vertical pipes spaced widely apart, which at the grate level are screwed into branch connections, from which the pipes are then carried up in pairs and connected with tees and four way fittings with the nests of generating tubes, which occupy the space all above the combustion chamber and below the drum, and form the principal heating surface of the boiler. These rows of tubes, rising from the bottom manifolds, and extending from back to front of the boiler, divide the furnace into three grates for each of which a door is provided in the casing. The tubes composing the generating system are in short lengths and are fastened together by nipples which are screwed into the end connections, the latter being faced and butted up tightly, so as to protect the threads from drical double ended marine boiler. At each end of the section manifolds or headers a plug is fitted, which on removal, permits of examination and cleaning of these manifolds and also permits the introduction of wrenches to unscrew the connecting nipples, so that a damaged tube may be readily removed and replaced. In the steam generating tubes the circulation is not all in one direction; in some the flow is upward and in others downward, the pipes above the nests of tubes with outlets into the drum carrying up comparatively little water to the drum. Inside the drum there is fitted a dry pipe and separator connecting on the outside with the boiler stop valve, and it is claimed by the manufacturers that their boiler is notable for furnishing dry steam. This boiler has been installed on several yachts and other vessels on the Great Lakes. It is manufactured by the Detroit Screw Works, Detroit, Mich.

Roberts Water Tube Boiler.

When completed, ready for steaming, this boiler is wholly contained within a square box or cube-shaped casing, the only projecting portions being the various connections, such as main steam pipe, feed, blow off, and guages. It is of the submerged small tube variety and in its more usual form consists essentially of three parts—the generating system, the superheater, and the feed heater. The steam generating section of the boiler consists of a steam and water drum at the top of

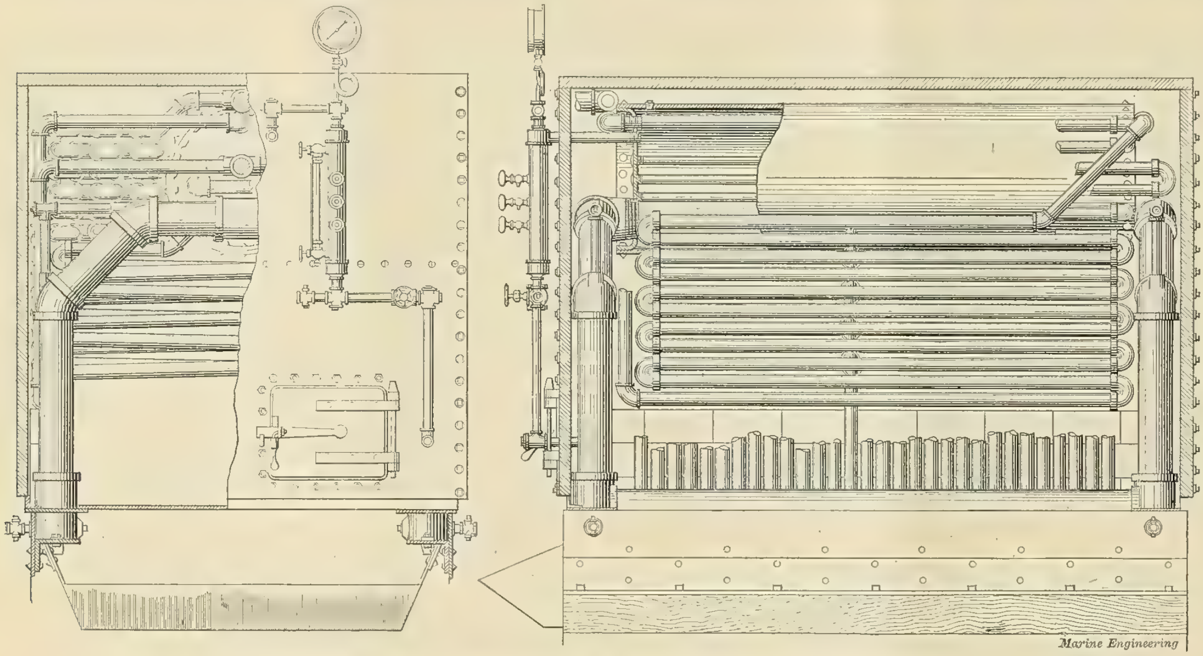


DRAWINGS SHOWING CONSTRUCTION OF THE TAYLOR WATER TUBE BOILER.

the action of the fire, and forming top and bottom headers. Between the drum and the casing on each side—one tube for each section—two rows of tubes extend upward from the generating nests and connect by bends with the drum. The connections at the lower ends of the generating tubes are arranged to form the crown sheet in such a way as to compel the gases to travel in the course indicated by the arrows in the drawing, which is somewhat the same in general direction as in the cylin-

the boiler over the combustion chamber, placed lengthwise from back to front. This is supported on a frame of large-sized downflow pipes, outlining three sides of the box at front and back, the grate forming the remaining side. The lower ends of these pipes are connected by T pieces, with "side pipes" at the level of and parallel with the grate bars. The upper surfaces of these side pipes are drilled and tapped to receive the lower and vertical ends of the "upflow coils," the length

of these lower ends regulating the height of the firebox. The coils consist of straight lengths of pipe laid horizontally and connected at the ends by malleable steel bends. The upper ends of the coils enter the bottom of the steam drum in a row at each side, a little off the center. By staggering the coils the space between the tubes over the fire is made only one-half that between the vertical ends at the sides of the furnace. At the sides of the boiler the superheating coils are laid at right angles to the generating coils. Connection is made between a "spray pipe" in the interior of the drum and the top of the superheater coils at both sides, and from the bottom of each coil a vertical pipe rises and connects with a cross pipe, with T piece at the top—front—of the boiler, to which the steam main is connected. The superheater coils are not carried down as low as the bottom side pipes, the space left being filled with fire bricks, which rest on the bottom frame of the casing, and form a backing to the lower ends of the generating tubes. On top of the generating tubes on each side and above the coiled portions of the superheaters the feed coils are located. The steam drum being of much smaller diameter than the width of the boiler, the feed coils lie snugly between the drum and the sides. A T placed outside the boiler front admits the feed to the upper rows of the feed coils, and from there it flows downward and into the drum above the water line, the coils being connected at their outlets to opposite heads of the drum. In operation the gases pass upward through and over the various coils of pipe —generating, superheating, and feed—to the top of the casing, in the center of which the outlet to the stack is placed. The upflow coils first becoming heated cause the water to ascend from the side pipes to the drum, where the steam and water separate, the steam escaping to the "spray pipe," already referred to, and the water flowing towards the ends of the drum where it reaches the downflow pipes. At the bottom of each downflow pipe there is a sediment pocket fitted with a blow-off cock. The boiler is stated by the makers to be made of "special" material. All the joints are screwed—there are no expanded joints in the boiler—with standard pipe threads, and the boiler can thus be shipped in parts and erected where needed with ordinary tools. It is made with plain or special grates for burning either coal or wood. The boiler is manufactured by the Roberts Safety Water Tube Boiler Co., 39-41 Cortlandt St., New York.



DRAWINGS SHOWING CONSTRUCTION OF THE ROBERTS WATER-TUBE BOILER.

S. Y. Victoria and Albert.—A serious mishap befell the new British royal yacht *Victoria and Albert* at Pembroke dockyard recently. Preparations had been made to float her out of dry dock, and when enough water had been let in to float her off the blocks it was found that she would have a considerable list. An effort was made to close the dock again, but the caisson jammed, and when the tide fell the vessel settled on her bilge sustaining some structural damage, though later she was floated again and towed to her moorings. Various criticisms regarding her stability have been published, and it appears to be the fact that some structural changes have been made on this account.

President James J. Hill, of the Great Northern Railroad, who has been credited for some time with the intention of putting a fleet of vessels of immense size in operation on the Pacific coast, to trade to the Orient, is now reported to have given particulars of the scheme. The vessels for the proposed route are to exceed 700 ft. in length and to have a carrying capacity of about 22,000 tons, the intention being to carry vast quantities of freight at economical speed across the Pacific.

Germany is now considering an enormous increase of its navy, the proposed expenditure being not less than $500,000,000.

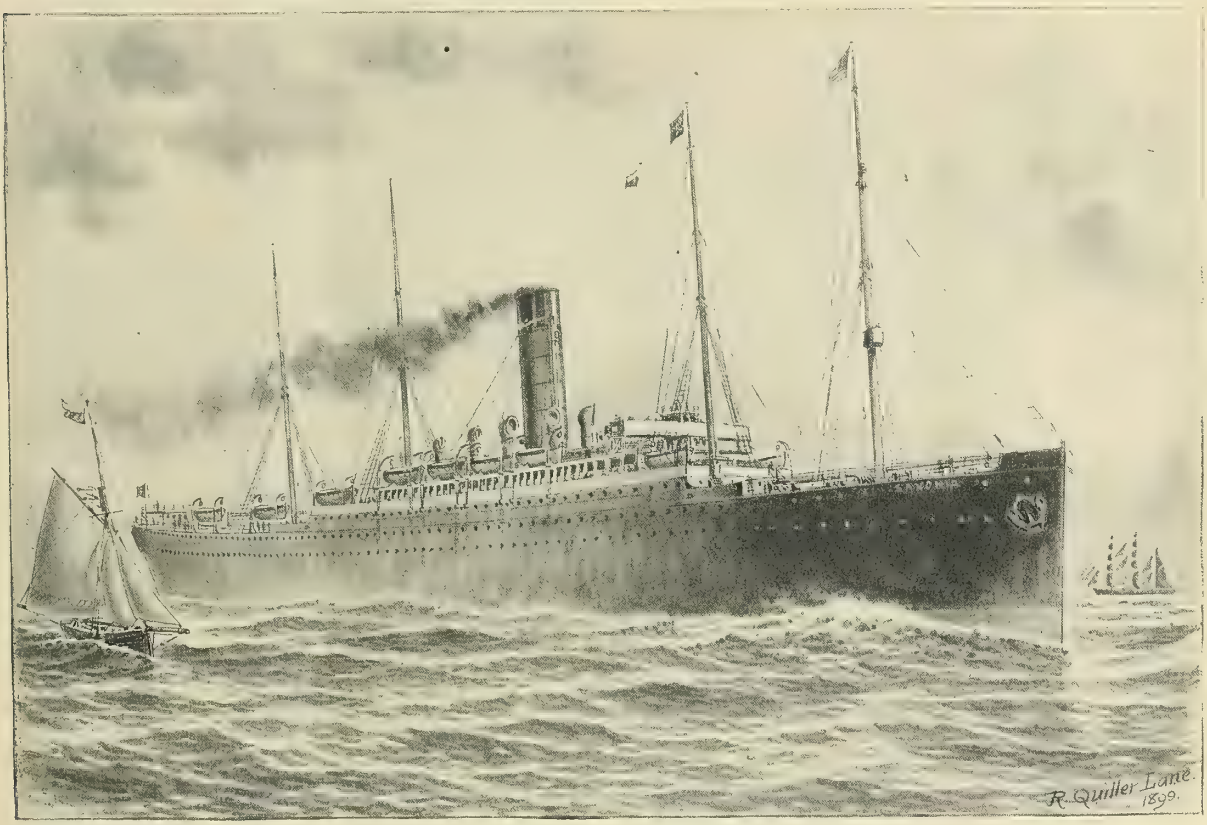
ADDITIONS TO FLEET OF THE CUNARD LINE—S. Ss. SAXONIA AND IVERNIA.

Two important additions to the Boston-Liverpool service of the Cunard line will be made on the completion of the steamships *Saxonia* and *Ivernia*, now building in British yards for the company. In the accompanying engraving the artist has depicted the *Saxonia* steaming at sea, on a transatlantic trip, with the Stars and Stripes flying at the fore. In December the *Saxonia* was launched at the Clydebank yard, now a consolidation of the J. & G. Thomson and John Brown & Company, the armor plate makers of Sheffield, where the well known liners *Paris* and *New York* were turned out. The *Ivernia* was launched about three months ago at the yard of Swan & Hunter, on the east coast of England.

It is undoubtedly the active competition of other lines trading to Boston that induced the Cunard Company to build these ships. For years the Boston passenger boats of that line have been famous for their slowness and general out-of-dateness. In recent days the company put on three large modern cargo and cattle steamers, the *Sylvania, Carinthia,* and *Ultonia.* These vessels were, however, no addition to the facilities for carrying cabin passengers on the route.

Both the *Saxonia* and *Ivernia* are liners of the intermediate type, built primarily for carrying freight at a moderate speed, but yet having up-to-date accommodations for a large number of passengers, both cabin and steerage. As a matter of fact the modern additions to the various transatlantic lines are mostly of this type, which is much more profitable to operate than the "record breaker," and for passengers who are not pressed for time on the ocean voyage a more satisfactory ship, everything considered. In dimensions the two vessels will take place near the top of the list of all steamers afloat. The principal dimensions of the *Saxonia* are as follows: Length, between perpendiculars, 580 ft.; over all, 600 ft.; beam, extreme, 64 ft. 3 in.; depth, moulded, from upper deck, 41 ft. 6 in. The gross tonnage will be about 14,000 tons, so that these ships will be the largest sailing to the port of Boston—the largest vessel now trading there being the *New England*, of the Dominion Line, of 12,000 gross tons, which was described in a former issue.

Passenger accommodations will be provided on the *Saxonia* for 164 first-class in the deck house on the bridge deck and below; on the shelter deck aft for about 220 second-class, according to demand; while the steerage quarters for 1,000 will be on the main deck forward. The vessel will have four full decks: Lower, main, upper and shelter, and over the latter a bridge deck, on which the houses containing the library and social hall for cabin passengers will be located. The main dining saloon, which will seat 150 passengers, will be on the shelter deck, lighted by a dome and large side ports. The decorations and furnishings will be quite modern and a feature will be a more luxurious arrangement of steerage quarters than is usual. Passengers of this class will have bath-room facilities and an extensive promenade, with smoking rooms and ladies' room; with less gilt, perhaps, but otherwise as comfortable as those enjoyed by their fellow passengers in the saloon.



ORIGINAL SKETCH OF NEW CUNARDER SAXONIA, 14,000 GROSS TONS FOR BOSTON TRADE.

Mild steel is used in the construction of the hull, which will conform to the rules of the highest class of Lloyd's register. There will be eleven watertight compartments and a double bottom, and additional to the latter large tank space for the purpose of ballasting Cold chambers for the carriage of meat will have large capacity, an extensive refrigerating plant being installed.

Twin screws will be used, driven by quadruple-expansion balanced engines, with cylinders 28 1-2 in., 41 in., 58 1-2 in., and 84 in. dia. and 54 in. stroke, of about 10,000 collective horse power. Steam will be generated at 210 lb. pressure in nine single ended Scotch boilers, worked under the Howden system of forced draft. At sea a speed of 15 knots is designed for.

In the way of deck gear the *Saxonia* will be well equipped with steam capstans, warping and cargo winches, and steering gear.

The construction of these two vessels marks another step in the slow, but steady progress of this great line, as it will mean the introduction of the quadruple-expansion into its service on big ships.

The influence of the American built *St. Paul* and *St. Louis*—quadruple-expansion, Howden draft—is having its effect in transatlantic practice.

American Steam Yacht Eleanor

One of the handsomest of the large American steam yachts is the *Eleanor*, now owned by Mrs. J. W. M. Cardeza, of Germantown, Philadelphia. This fine sea boat recently arrived in the port of New York after an extended northern cruise. In July last the cruise began, and the first port of call after leaving New York was Newport, and afterwards Vineyard Haven, Nantucket, Portland, Rockland and Bar Harbor in succession. After touching in various places in the vicinity of Mount Desert Island the yacht sailed for Nova Scotian waters, calling at Digby, Halifax and afterwards at Sydney, Cape Breton, Charlottetown and Georgetown, P. E. I. A ten-day cruise through Bras d'Or lakes followed, and then a return was made to Sydney, C. B. for coal. From there the yacht sailed for Port au Basques, Newfoundland, where a hunting party made up from those on board spent two weeks ashore in the woods after caribou. The hunters were so successful that on the return voyage the yacht touched at Bangor, Me., and twenty-six fine caribou heads and hides were sent to be prepared for trophies. Mrs. Cardeza, who is a splendid shot, carried off the honors by bringing down the largest caribou on the trip. On October 15 last the *Eleanor* left the Bay of Islands, calling at various ports from Sydney, C. B., to those in the Sound, on the way to New York.

The *Eleanor* is an American yacht in the strict sense of the term. She was built about six years ago at the Bath Iron Works, Bath, Me., for W. A. Slater, of Norwich, Conn., who owned her until about fifteen months ago, when the sale to the present owner was made. The first voyage made by the *Eleanor* extended around the world, and since that time she has cruised in the fjords of Norway, in the Caribbean Sea and elsewhere, having steamed altogether about 80,000 miles. Mrs. Cardeza proposes soon to sail for an extended cruise in the Mediterranean.

A few particulars of the dimensions and equipment of this vessel will be of general interest. Her dimensions are as follows: Length, 234 ft.; beam, 32 ft.; depth, 17 ft. 5 in.; draft, 14 ft. 5 in.; gross tonnage, 803 tons.

VIEW OF STEAM YACHT ELEANOR OFF STARBOARD BOW.

She is built of steel, is bark rigged, and has a single screw driven by triple expansion engines, with cylinders, 18 in., 28 in. and 46 in. dia., and 30 in. stroke, indicating 1,100 horse power. Steam is supplied by two Scotch marine boilers, 11 1-2 ft. long and 12 ft. 5 in. dia., with six furnaces in all. There is a bunker capacity for 300 tons and fresh water capacity for 22,000 gallons.

Under steam (natural draft) a speed of about 14 knots is maintained, and with canvas alone and a good breeze the yacht will average 8 knots. She carries a crew of forty-four men all told, and Captain D. A. Weed, of Rockland, Me., is her skipper, and the machinery is under the supervision of Chief Engineer W. C. Bonning, of Brooklyn, N. Y. The *Eleanor* cost in the neighborhood of $300,000 ready for service, and the cost of maintenance is not far from $100,000 a year.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATÉRIEL.—I.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

In our society, the president has the widest latitude in the choice of a subject for his annual address, and, indeed, there is scarcely an established custom as to its nature; but it always seems logical for him to choose a theme connected with the work to which his life has been devoted, and in which he is an expert. This would make my subject, "Naval Engineering," and there are several reasons why it is particularly appropriate at this time. Although one other naval engineer has been president of the society, his address had a different theme, and consequently the subject, at least as a presidential address, will be new. Moreover, this year marks a very decided change in the personnel of engineering in our navy, so that it is particularly appropriate that one of the engineers of the old school should, at the close of this chapter in the history of naval engineering, give a brief review of some of its more important facts with respect to both personnel and matériel.

Every American is naturally proud of the fact that the first successful steam vessel was the work of an American engineer; but it is not so generally known that the first steam war vessel of any navy was designed by the same American (Robert Fulton) and was built in this very city in 1814. Had the war with England lasted a little longer there can be no doubt that the *Demologos* would have created a revolution in naval architecture; but the close of the war before she was completed rendered her active service unnecessary, and she was finally destroyed by an explosion of her magazine in 1829. The advent of the *Demologos* did not create an engineer corps, nor bring any engineers into the navy, so that the real beginning of naval engineering was when the steamer *Fulton* was built, and in 1836 Charles H. Haswell, the Nestor of engineering in this country, became the first chief engineer in our navy. The *Fulton* was a small vessel of only 1,200 tons displacement, or about what would now be considered a small gunboat; but she was the beginning of what has brought about as great a change in navies as the invention of gunpowder did in warfare.

It is really wonderful to think that the man who was the first chief engineer of this first steam war vessel of our navy is still alive, in full possession of his faculties, and in the active practice of his profession to-day. One of his contemporaries some years since said that the Engineer Corps might consider itself very fortunate in having had for its founder such a man as Mr. Haswell, an educated gentleman and a thoroughly competent engineer. From the very first his every effort was devoted to increasing the efficiency both of the machinery and of the officers who were to care for it, and it is not going too far to say that he has left a lasting impression by his labors, the organization and scheme of examinations having long remained as he made them.

It is a little hard for the young engineers of to-day, whose training, while it may seem to them beset with difficulties in the way of intricate formulæ and abtruse calculations, is nevertheless complete, and makes them masters of an immense amount of accumulated information, to realize the difficulties under which the older engineers, even of the writer's generation, and much more so of Mr. Haswell's, labored. Mr. Haswell himself was one of the first to provide a reliable book of

AMERICAN BUILT STEAM YACHT ELEANOR, OWNED BY MRS. J. W. M. CARDEZA, OF PHILADELPHIA.—SEE PAGE 78.

*President's address (1899) at New York meeting of American Society of Mechanical Engineers.

reference for the young engineer, where the results of experience were systematically arranged; but for Mr. Haswell himself there was nothing of this sort, and he had to create the precedents. When we look at the matter in this light, we are filled with admiration for Mr. Haswell and the men of his generation at their excellent solution of the problems which confronted them.

Without going into a detailed sketch of the work done by Mr. Haswell, it may not be amiss to recall to your minds a famous old ship, the machinery for which was designed by Mr. Haswell, who, indeed, made all the drawings for it himself. This vessel was the *Powhatan,* which for many years was one of the finest of our old ships and rendered most efficient service. Probably every member of the society living near our eastern coast has seen this fine old ship. She was built in 1847, and remained in active service for forty years, a monument to those who had designed and built her.

In those early days the average deck officer of the navy did not look upon the steam engine as a desirable addition to a ship, but simply as a necessary adjunct that had to be endured. There were, of course, notable exceptions, and Captain Matthew C. Perry, the first commander of the *Fulton,* was a liberal minded man to whom engineers owe a great deal. Yet, even he hardly rose to the point of considering that engineers were a vital part of the ship's complement, and as such should be made to feel that they were as much officers as any others, and their men were just as truly sailors. Neither Mr. Haswell, nor any of his assistants, were regarded, when first appointed, as permanently in the navy, and the assistant engineers were removable summarily by the commandant of the station. Some years ago Passed Assistant Engineer Bennett, writing for one of the reviews, in speaking of this circumstance, expressed surprise that the deck officers should not have realized the mighty force which steam brought to them and have embraced every opportunity to take advantage of it. It seemed, on the contrary, to belong to a different world from that in which they had been trained, and instead of endeavoring to become expert engineers, they regarded the machinery and all connected with it as a disagreeable necessity and left its development to the separate Corps of Engineers.

Among the older engineers were many men well known to all mechanical engineers in the country, who in a quiet way did very valuable work. Time will not permit, however, of mentioning them individually in such a survey as we are making.

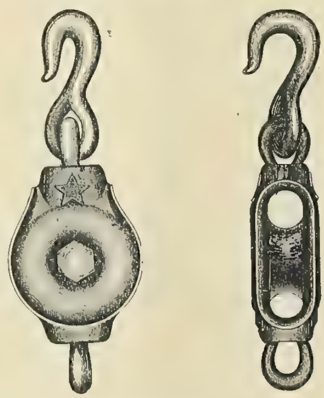
Some years before our civil war another great marine engineer began to attract attention—Benjamin F. Isherwood. He entered the navy in 1844, so that he is really a contemporary of Mr. Haswell. It is perhaps not exaggerating to say that he is the most brilliant marine engineer whom this country has seen, and his work has made his name known among marine engineers in all parts of the world. His fame will probably rest mainly on his record as an experimentalist, in which field there are few who have ever exceeded him, either in the amount or the excellence of the work done.

Preliminary trials of the U. S. torpedo boat *Goldsborough* 250 tons, at Portland, Ore., are reported to have turned out very satisfactorily.

IMPROVED APPARATUS.

Tarbox Tackle and Block.

A new style of tackle block has recently been patented by Alfred B. Tarbox of Boston, which is remarkably simple in construction, strong, and can be manufactured at less cost than the ordinary forms. The construction of this block, as will be seen by inspection of the accompanying sketch, gets rid of all rivets or pins other than the sheave pin or axle. The cheek pieces, which can readily be made by casting or stamping, are provided at the ends with lateral extensions projecting from the inner sides. When the cheek pieces are brought together these extensions interlock and the shell is formed. Suitable recesses are cast or stamped in the interlocking pieces at the ends for the reception of the shanks of the shackles, without the need of machine work. The cheek pieces are swelled inwardly at the centers, forming a boss or hub, with a plane face on the interior, against which the hub of the sheave bears. Through the center of this boss the sheave pin passes,



TARBOX PATENT BLOCKS.

being secured outside on each end by a lock nut. The nuts are sunk in the depression on the outside of the cheek pieces, and hence the block has practically a flush face at each side. The sheave pin not only serves as a journal but holds the frame or shell together. The edges of the cheek pieces are rounded inwardly so that chafing of the sheave rope is not possible. Blocks with more than one sheave are made on the same principle, with slight modifications in design. These blocks are now being manufactured by the Boston & Lockport Block Co., 142 Commercial street, Boston, Mass.

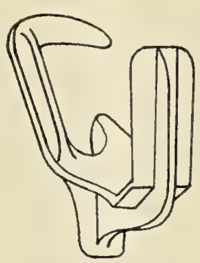
"Durable" Wire Rigging.

A cross section of the "Durable" wire rope presented in the engraving has a close resemblance to a section of submarine telegraph cable. This new style of rope, which was only recently patented and put on the market, differs from the ordinary wire rope in that each strand is separately served with fibrous material before the rope is laid up. By this means a rope is secured which has many of the qualities of the hemp or manila rope, while retaining the strength of the wire rope; and bulk for bulk the new rope is stated by the patentees to be from 7 per cent to 10 per cent stronger than

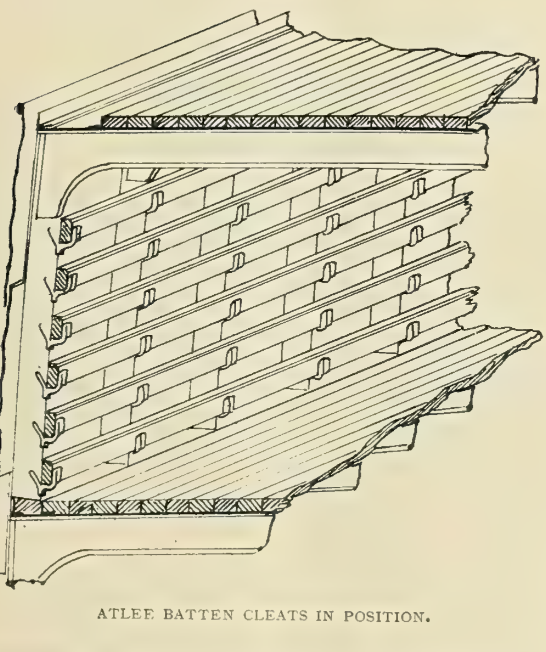
the ordinary wire rope, about 25 per cent. more flexible, and from three to six times as durable. Serious deterioration of the ordinary wire rope is caused by the wear of the strands against each other and against sheaves and drums in the case of running rope, while in the new rope the sheathing gives a cushioning ef-

"DURABLE" YACHT RIGGING.

fect and permits an even bearing of the rope against the surfaces over which it passes. In the case of standing rigging the protection of the wires from the action of the weather tends towards long life, and where the rope is used for towing hawsers or anchor roads, the



SINGLE CLEAT.



ATLEE BATTEN CLEATS IN POSITION.

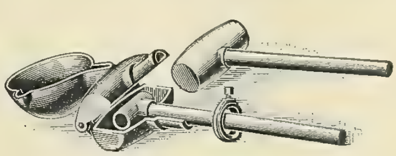
corrosive action of the water can be practically neutralized by saturating the covering with oil. The engraving shows the galvanized cast steel wire rigging manufactured for yacht and ship use. It is composed of five strands and a hemp center, with seven wires to a strand. The approximate breaking strain of a "Durable" rope of this style, 2 in. circumference, before serving, is 14 tons. As it is much lighter and smaller than ordinary galvanized rope of the same strength, it is specially recommended for yachts. The rope is manufactured by the John A. Roebling's Sons Co., for the patentees and proprietors, the Durable Wire Rope Co., 234 State St., Boston, Mass.

Cargo Batten Cleat.

In the engravings a new batten cleat is shown in position between decks, and also a single cleat. This is a cheap metal device, which is attached to the frame by simply drilling a hole for the hooked end to fit into. Those illustrated are for vessels with bulb angle frames, but another form is supplied for use in vessels with the ordinary frame and reverse frame. No tools are required to place the cleats in position. They are simply hooked in place and can be speedily removed at any time when the nature of the cargo demands this. This is one of the advantages of the Atlee cleat, for it can be used again and again. The cleats are made of either cast steel or malleable iron, and are practically indestructible. Joshua W. Atlee of Riverton, N. J., is the patentee.

Combination Mould and Handle.

This compact device enables the user to readily produce soft metal hammers for shop use, with the aid only of the metal and any convenient fire. The mould, as seen, is in two pieces, with the ladle attached to the upper half, the mould being closed ready for pouring by simply slipping the ring or dog over the end of the shank. The handle for the hammer is made of ordinary iron pipe, with a T piece on the head end. This is inserted in the mould, as shown, and when the ring is slipped in place, and the metal in the pot is melted, the mould is tipped up so that the metal flows down into



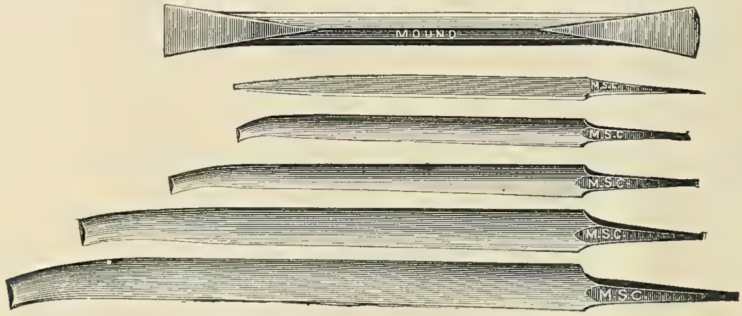
COMPOSITION HAMMER MOULDS.

the mould through an aperature in the top, filling up the space between the T piece and the inside of the mould. There is no possibility of the head of the hammer being jarred off by repeated blows in use, and the heads can be recast without delay when worn out of shape. The ladle is also fitted with a lip of the usual form, so that it can be used for other purposes. It is manufactured by Charles H. Field, 42 Point street, Providence, R. I.

Steel Scraping Tools.

In these days of precision in shop work the aid of all tools and appliances that will produce exact results, with the least expenditure of time, is called in by the en-

gine builder. As supplying a need in this direction, the Mound Tool and Scraper Co. has put on the market a set of scraping tools held in a neat oak case, so that they can always be found together in the tool room. The scrapers are made of the best tool steel, carefully forged, finished, and tempered, so that they are true in shape and possess the proper temper for effective work. This set is of special value for use in the marine engine room, where the scraper is indispensable, and where work has often to be done in haste, yet accurately, and there is neither time nor probably facilities for making the needed tools. In addition to this regular set the company also makes special sizes and shapes on order. Its address is 712 Howard street, St. Louis, Mo.



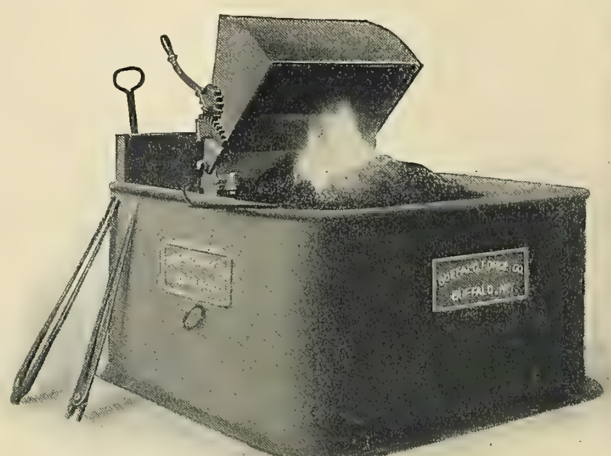
MOUND TOOL SCRAPER SET.

Down Draft Forges.

One of the most marked improvements in the equipment of blacksmith or angle smith shops is the substitution of down draft forges for the old fashioned fires with hood and vertical smoke pipe. The advantages of this modern system are many. No obstruction is offered to the handling of large or bulky material, and the use of overhead cranes is possible. There are no unsightly pipes to be taken care of, and as a consequence, the shop looks cleaner and can be better lighted; both items which contribute to the comfort of the men. Then the fouling of the air in the shops is avoided, as all smoke and gases are removed immediately on being generated at the fire, and carried through underground pipes to the point of exit. The system adopted by the Buffalo Forge Co., one of whose heavy forges is illustrated in the engraving, can be installed in two ways: First, with separate fans, that is a blower for furnishing the blast and an exhauster for carrying off the smoke and gases; second, with a combined blower and exhauster in which a portion of air is forced through the blast piping for supplying air to the hearth, and the remainder discharged into the smoke pipe, thus creating a strong draft. The forge shown is made exceptionally strong for engine or heavy ship work. Engineers who contemplate the location of new shops, or the extension or the modernization of old ones, can procure further information from the manufacturers, Buffalo Forge Co., Buffalo, N. Y.

Crank Shaft for Russian Cruiser.

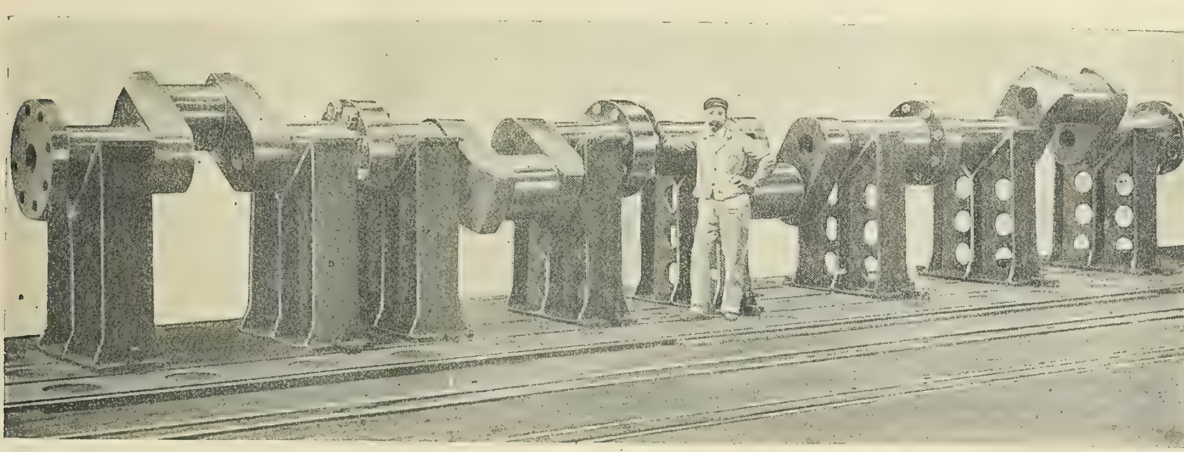
One of the four throw crank shafts for the Russian cruiser *Variag*, being built at Cramps, is shown in the accompanying engraving reproduced from a photograph of the crank in the shops of the makers, the Bethlehem Steel Company, before shipment to Philadelphia. The shaft is made of special open hearth shafting steel, and is guaranteed to possess an elastic limit of not less than 36,000 lbs. per sq. in., with good elongation. The forgings of which this is a type were produced under heavy hydraulic-presses at the Bethlehem plant, and, after being carefully annealed, were finish-machined complete and fitted together there as shown. They are similar to the shafts made bv the same company for the Russian battleship *Retvizan*, both vessels being built at the Cramp yards in Philadelphia, as already noted. In addition to these forgings, the Bethlehem Works furnished all the straight shafts for both ships, together with the engine-columns, crossheads, piston-rods and connecting-rods, the last two being made of oil-tempered nickel steel, to give special physical qualities. All of this material was subject to the specifications and test prescribed by the Russian Marine Ministry, and was produced under the personal supervision of navy officers detailed by the Russian Government for this purpose, and who were stationed at the works. Such work as this is only another illustration of the confidence with which foreign governments regard American products. But although the work is of such high class, it may be said to be a matter of ordinary routine at the Bethlehem plant, which is equipped with such facilities as to enable it to meet successfully the most rigid specifications known to modern science.


BUFFALO DOWN DRAFT FORGE.

Coaling Vessels at Sea.

At the recent meeting of the Society of Naval Architects and Marine Engineers, a paper was read by Spencer Miller on methods of coaling warships at sea, in which the apparatus he had designed was explained. Our readers will recall the abstract of his paper published in the report of the meeting. Since that time further experiments have been carried out by the Navy Department, using this apparatus at sea off Sandy Hook, the collier *Marcellus* and battleship *Massachusetts* taking part in the trials. In the accompanying engraving the position of the vessels during the coaling operations is shown. They were at a distance of from 300 to 400 ft. apart, depending on the condition of the sea. On the collier there was mounted an engine with two drums or reels; a small wire rope, 3-4 in. dia. was led from one drum or reel to a sheave at the top of the foremast and thence across to a sheave mounted above the quarter deck of the warship, returning by a parallel route to another drum or reel. A load carriage of novel design gripped the upper branch of this elevated rope, and was forced to travel by the reciprocating motion of the rope to and from the warship. From the carriage were suspended two bags of coal weighing 840 lbs., and by disengaging gear these were dropped into a canvas chute over the quarter deck of the warship at the rate of one load per minute, or from 20 to 25 tons per hour. The rope was operated by one drum or reel winding in one end of the rope, while the other drum or reel was arranged to wind the rope and also to slip when needed. Thus one drum gave motion to the rope and the other kept the requisite tension in the rope while it was paying out, so that the coal bags were carried with sufficient clearance over the water. The supports for the apparatus were the foremast of the collier and shear poles on the *Massachusetts*, and these were held by steel guy ropes much stronger than the small wire ropes which carried the loads across. By the use of this conveyor if the boats lurch apart, one rope simply slips to accommodate it, and if the boats come together either one drum or the other winds it in at a speed faster than the ships can approach one another. The invention employs besides the conveying rope, an auxiliary rope known as the sea anchor line, which is solely employed to prevent the carriage from twisting when returning unloaded from the warship. This sea anchor line is secured by a lashing or knock-off hook to the warship and passes over a pulley on top of the carriage, from thence it is led through pulleys on the two masts and then astern several hundred feet into the sea. On its end is secured a canvas cone dragging with its mouth towards the warship and known as the sea anchor. The apparatus employed in these tests was manufactured by the Lidgerwood Mfg. Co., New York.

TEST OF MILLER COALING APPARATUS AT SEA.



FOUR-THROW BETHLEHEM STEEL CRANK SHAFT FOR RUSSIAN CRUISER VARIAG—SEE PAGE 82.

MARINE ENGINEERING

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AMONG persons interested in shipping, more especially, the action of Congress in the matter of ship subsidies is awaited hopefully, with the expectation that the development of our merchant marine will receive adequate treatment. Our mission is not political; but as the subject is really commercial rather than political, we offer no excuse for this reference. Indeed, there is no subject occupying the minds of public men to-day which, in our opinion, is of more vital consequence, or likely to cause progression or retrogression of the country as a commercial nation, than the expansion of the American merchant marine. Our opinion as to the best course to be pursued has already been stated—a thorough and impartial investigation of the subject as a whole by a competent commission, and united Congressional action when a correct judgment has been reached. Probably this would be expecting more than the attainable, for there is a manifest desire in influential quarters to make political capital out of the whole subject, and, in fact, to make it a party measure. Sectional differences of interest are already being worked on to obstruct any measure that will make the American flag known in parts of the earth which have long since forgotten its colors. It is unfortunate that the question of Federal aid can be readily placed before the uninformed—by those who know better—in such a light that it looks like an attempt to benefit the few at the expense of the many. The great bulk of the population is inland, far removed even from the sight of an ocean and with immediate interests that take attention and effort away from things maritime. But even proximity to the sea has not, in many instances, increased the knowledge of those who treat of this subject; or is it that knowing the truth they desire to conceal it in a non-conducting covering of words for partisan purposes? Honest discussion seldom forms part of the procedure of practical politics. At any rate, it is remarkable how little in the way of real argument against Federal aid has been advanced on the platform or in the press. There are denunciations and criticisms in plenty, but no statements of any practicable alternative. None of the academic authorities has yet shown how freight can be carried competitively in American bottoms, under existing conditions in the world-wide trade. For example: placing an American and a British vessel of exactly the same type and dimensions alongside the same wharf, we find the former vessel represents a much larger original investment, and the operating expenses very greatly in excess of those for the British ship. How then is it possible for the American owners to charge the same rates and exist? American genius has not yet evolved any magic method by which a vessel can be propelled without the consumption of fuel and stores, nor has any means been devised whereby a skipper can touch a button and the vessel does the rest. It still requires the intelligent co-operation of a number of highly skilled men to get a steamship from one port to another, and these men are entitled to a wage equivalent to that enjoyed by those of the same capability or responsibility ashore. This seems a very simple statement, but it is one that is too often ignored, and it is the key to the situation. It ought not to be a necessity at the close of this century to point out to those in high places the tremendous benefits which result to a country from the possession of an adequate merchant marine. If no higher argument will prevail, the vast sums of money annually paid out by Americans to stockholders in foreign steamship corporations for the conveyance of American goods should be sufficient reason for action. In argument, or rather misstatement, a comparison is frequently made between shipbuilders and loco-

motive builders as to their ability to meet foreign competition. As to that, the locomotive builder has only reached his present position by the skill which the vast numbers of machines he has turned out has compelled. He has not only built engines in units but in tens, and to a great extent in duplicate orders, and has thus reached a condition of standardization unknown in shipwork. Again, the American type of locomotive is peculiarly adapted to service in "new" countries. In the case of ships there are no "new" seas for which we can specialize, there is little or no uniformity in type or duplication of orders, no standardization, and, more important than all, no continuous flow of orders that would warrant the investment of vast sums in special tools and special stock. Exceptions to this can be found on the Great Lakes, but those interests are outside this discussion.

BRITISH shipbuilding returns for the year 1899 show an increase over the figures for 1898; the respective totals being in round numbers, 1899, 1,650,000 tons, and 1898, 1,600,000 tons. These figures include all steam and sail tonnage launched from private yards. To this, therefore, must be added the vessels launched from the navy yards nearly 70,000 tons, to get the grand total for the year. Of the year's total about 350,000 tons were for foreign owners, our contribution to this total including the U. S. S. *Albany*, 3,700 tons, launched by Armstrong, Whitworth & Co., at Newcastle-on-Tyne, January 14, 1899. Engineering returns show that the output of propelling engines exceeded 1,500,000 indicated horse power. An inspection of the reports which make up the totals show that many vessels of the largest size were constructed, and that a large proportion of the big ships were for regular steamship lines. Largest of all was the *Oceanic*, and others of the first rank were the *Saxonia* and *Ivernia*, 15,500 tons, for the Cunard line, the *Bavarian*, 10,370 tons, for the Allan line, the *Saxon*, 12,970 tons, for the Union (South African) line, and two Castle liners (South African) of 10,000 tons each. There were in all sixty vessels built with a tonnage exceeding 6,000 tons. At the head of the list in tonnage launched comes Harland & Wolff, of Belfast, Ireland, with a total of 82,634 tons. Among the Scotch yards Russell & Co., of Port Glasgow, who were at the top of the list in 1898, again came out first with 52,400 tons. English builders were headed by William Gray & Co., Ltd., of the East Coast, with 77,500 tons, who the previous year had the largest output of any builder to their credit. Sail tonnage formed only a very small proportion of the total output, less than 40,000 tons.

TWO important meetings of engineering societies were held in Washington last month, each representing the engineering interests of the Navy and Merchant Marine respectively. On January 8, the American Society of Naval Engineers held its annual meeting, at which the election of officers for the following year resulted as follows: President, Commander Harrie Webster; Secretary-Treasurer, Commander G. S. Willits; Members of Council, Lieutenant Commander F. H. Bailey, Lieutenant B. C. Bryan and Lieutenant R. G. Griffin. An increase in membership was reported. In the competition for the prize essay the first prize (gold medal) was awarded to William F. Durand, of Cornell University, and the second prize to B. C. Ball. At the annual convention of the Marine Engineers' Beneficial Association, held later in the month, there were more than fifty delegates present. The national officers for 1900 elected were: National President, George Uhler, Philadelphia, Pa.; National Vice-President, Frank A. Jones, Alameda, Cal.; National Secretary, George A. Grubb, Chicago, Ill.; National Treasurer, Ed. R. Blanchard, Detroit, Mich.

READING the report of Captain G. W. Pigman, commander of the late U. S. cruiser *Charleston*, which narrates the circumstances attending the loss of that vessel, we felt that it is almost worth the loss of a ship to demonstrate the kind of stuff the personnel of our Navy is made of. In time of naval war it is to be expected that every man will do his duty, and the stir and fever of battle nerves many a man to more than ordinary human effort. It is when sudden and unexpected disaster rushes a man face to face with death that his real qualities and the results of his training are shown. In this generation there have been many sore trials of American naval valor in peace time, at Samoa, at Cuba, and now at the Philippines, and in each case the real grit of our Navy has been shown.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—IV.

BY DR. WILLIAM FREDERICK DURAND.

§3. CORROSION.

No sooner has a boiler been completed than the various corrosive and destroying influences with which it is surrounded set to work on its destruction. We may conveniently consider corrosion as of two kinds, that due to oxygen and that due to an acid. These two are, however, by no means independent, and are often combined in very complex ways. The process by which oxygen combines with another substance is called *oxidation*, and the product of the operation an *oxide*. In the case of iron and steel the typical product is the ordinary red iron rust, or ferric oxide (Fe_2O_3), consisting of about 56 parts by weight of iron and 32 of oxygen. In order that oxidation or rusting of iron may continuously proceed at ordinary temperatures, however, it is not enough that oxygen and iron shall be in contact. It requires the additional presence of moisture and carbon dioxide (CO_2), small proportions of which are always present in the atmosphere. Oxygen and moisture alone act feebly and very slowly on iron, but when the four substances, iron, oxygen, moisture, and carbon dioxide, are all present together, the operation of rusting proceeds continuously and with vigor. Oxide is first formed, and this is reduced by the carbon dioxide to a carbonate, and this in turn breaks up forming hydrated oxide ($FeHO_2$), setting free the carbon dioxide to continue the process. The hydrated oxide thus formed is furthermore electro-chemically negative to iron, and thus helps on the operation as explained at a later point. If either the moisture or the carbon dioxide is absent the oxygen will have little or no effect, and the iron will be protected. This is shown by the non-rusting of iron in perfectly dry air, even though there may be some carbon dioxide present; or again, by its preservation in a weak alkaline liquid, as lime water, in which there can be no free carbon dioxide. The piano wire used in certain forms of deep sea sounding apparatus, for example, is thus kept from corrosion under conditions which would naturally soon destroy its regularity and value for the purpose used.

Acid corrosion means the attacking of a substance by an acid, the breaking up of the latter, and the formation of a new substance known as a *salt*, and composed of a part of the acid and of the substance attacked. Thus hydrochloric or *muriatic* acid (HCl), as it is commonly called, is sometimes present in boilers. This is composed of hydrogen and chlorine. When it is brought into the presence of iron or steel the chlorine leaves the acid, and joining with the iron, forms a salt known as ferrous chloride, or chloride of iron ($FeCl_2$). With iron rust and muriatic acid the result would be similar, the chlorine would join with the iron and form ferrous chloride, while the hydrogen of the acid would join with the oxygen of the oxide and form water.

As before stated, acid corrosion and oxidation are very commonly both present, especially in the latter operation, and in fact the continued operation of oxidation with iron, moisture and carbon dioxide is dependent on the combined action of both operations. We shall not, however, deal further with the chemical details of corrosion in general, but proceed to a brief consideration of the causes, effects and remedies as related to corrosion in marine boilers.

Taking first the exterior of boilers and of all exposed iron and steel work in general, it is clear that the conditions for continued rusting are all present on board ship. The air is moist and there is likely to be present carbon dioxide in abundance. The only safe protection is, therefore, a covering which shall keep the air moisture and carbon dioxide from contact with the iron. To this end metal paint or other equivalent coating is used wherever possible. Many small fittings, especially about the deck, are of galvanized iron, that is, iron covered with a thin coating of zinc. The latter metal is but slightly affected by the process of oxidation, and it therefore forms an efficient protection for the iron. Brass, bronze and copper are also oxidized but slightly, and the oxide formed serves as a protective covering to the metal underneath. For this reason, among others, many of the fittings about boilers and elsewhere are, as we have already seen, made of these metals.

Passing in now to the fire side of the boiler, we find the application of paint or other protective coating impracticable. Here we must depend on the heat, which will so dry the air that it is no longer moist. That is, while water vapor may still be present in the air, there is so little compared with the amount the air could naturally contain at that temperature, that it is held by the air and is no longer free to enter as a factor into the operation of oxidation. Rusting in the usual way is, therefore, very much retarded or prevented. To this fact we owe the general preservation of the furnaces, ash-pits, etc., from serious and continuous corrosion. We here, however, run into another danger in the extreme case when oxygen is present in excess, and both the oxygen and iron are very hot. The oxygen in such cases enters more readily into union with the iron, and if the temperatures should be sufficient, a different kind of oxide is formed, the black, or magnetic oxide (Fe_3O_4), the same as the mill scale or forge scale, which forms when iron is worked at a red heat. The oxide thus formed may presumably be swept away by the scouring action of the draft, thus exposing a fresh surface to renewed attack. The back ends of the tubes seem especially liable to attack in this way, and particularly with hard forced draft. The cure for this trouble is found in the use of cast iron ferrules, as previously described.

These ferrules protect the tube ends from the extremes of temperature, and also provide something for the hot oxygen to attack, while they are readily renewed.

Turning now to the water side of the boiler, we find more serious trouble than with the fire side. There is likely to be more or less air in the feed water, either entering with the make-up feed, or occasionally drawn into the feed-pump and sent on to the boiler. There may also be free carbon dioxide liberated from the salts entering with the make up feed, and thus all the conditions for continuous rusting may be present. Even if free carbon dioxide is not present the formation of iron oxide, combined with electro-chemical reactions, as referred to later, may result in serious local corrosion.

Furthermore, as the feed-water is heated the air is liberated, and the oxygen just at the instant of liberation seems to be especially active chemically, and is thus all the more likely to attack exposed places than if allowed to remain in solution in the water, as at ordinary temperatures.

Turning next to acid corrosion, mention may first be made of the serious trouble formerly experienced from the use of animal and vegetable oils for cylinder lubrication. Such an oil is a compound of a fatty acid and glycerine. When exposed to a high temperature the fatty acid and the glycerine become separated. If a substance such as soda or potash is present, the fatty acid combines with it and forms soap. This process is called saponification. If, however, no such substance is present the acid will be free to attack other substances as it may be able. Fatty acids attack iron feebly, but if long continued the result may be a serious corrosion, resulting in the formation of what is known as an iron soap. The temperature within the cylinders and boilers was quite sufficient to thus decompose the oil, and there would, under such circumstances, be set free in the boilers an amount of fatty acid depending on the amount of oil used in the cylinders and finding its way into the condenser and feed-water. There were thus present all the conditions necessary for the corrosion of the interior of boilers by fatty acids, and many serious cases were laid, in part at least, to this cause. These troubles appeared especially with the introduction of the surface condenser, and the part which fatty acids might play being understood, the use of animal and vegetable oils for the lubrication of the cylinders was abandoned, and in their place hydrocarbon or mineral oils are now used. Such oils are derived as one of the constituents of crude petroleum, and are not compounds of a fatty acid and glycerine. They are compounds of carbon and hydrogen, and belong to an entirely different class of chemical substances. They do not produce a fatty acid on being heated, and cannot, at least directly, take part in the process of boiler corrosion.

In modern practice, therefore, nothing but the best hydrocarbon oil, entirely free from animal or vegetable admixture, should be used for cylinder lubrication. With lubricant of this character modern boilers should be free from corrosion chargeable to the action of fatty acids.

These are, however, not the only acids which have given trouble in the way of boiler corrosion. Under certain circumstances free hydrochloric or muriatic acid is found in boilers. This is presumably due to the breaking up of magnesium chloride, forming hydrochloric acid and magnesium hydrate. The most dangerous feature of the corrosion due to hydrochloric acid is that under conditions which may exist within steam boilers the chloride of iron first formed may become broken up, giving rise to other neutral compounds of iron, and setting free the acid to continue its ravages.

There are also possibilities of the development of nitric acid from the organic matter which in small quantities may occasionally find its way into steam boilers.

Except as it may be modified by electro-chemical action, the presence of such an acid usually results in a general surface corrosion, at least of all surfaces not protected by a sufficient layer of lime scale.

The most troublesome feature of boiler corrosion has not been, however a general or more or less uniformly distributed effect, such as would naturally be charged to the action of an acid diffused throughout the boiler. It has been rather in the so-called *pitting*. This term refers to the formation of small pits or depressions from the size of a pin head upward, and conical or cup-shaped in form. The depth of such pits may be anything from a slight depression to a hole cut entirely through a boiler tube. They are found in no fixed locality, though more commonly on the tubes, furnaces, and combustion chambers than elsewhere. When found they are usually filled with a blackish or brownish pasty mass, consisting chiefly of iron oxide with a slight admixture of lime salts, oily matter, and other substances. This deposit within the pits is often covered with a skin of somewhat different composition, consisting of lime salts and iron oxide in more nearly equal proportions.

To account for the formation of these pits, various explanations have been suggested, most of them involving *electro-chemical* action as a more or less pronounced feature. To understand the nature of this action a few explanations must first be given.

Nearly all substances are in a different electrical condition, or at a different electrical *potential*, as it is called. This difference is found not only between substances of different kinds, but also between similar substances at different temperatures, or in different physical conditions, as, for example, between two pieces of iron or steel, one of which has been hammered or worked more than the other. Due to this difference of electrical potential there is a tendency to set up a flow of electricity from one to the other, and as a further result to so change the two substances as to bring them into electrical equilibrium. In other words, the result of such a difference of electrical condition is always to bring about changes which will cause the difference to disappear, and so bring the two substances into equilibrium. These chemical changes of the two substances, which tend toward electrical equilibrium, may be much helped or hindered by the medium in which the bodies are immersed. If they are in dry air, for example, no such activity takes place, and the difference of electrical condition continues unchanged. If, however, they are immersed in water, or especially in salt or slightly acid water, the operation will usually be much assisted by the activity of the medium for the substances. It may also happen that the medium and substances are so related as to bring about a series of chemical changes, of which the first are those which would naturally be associated with the transfer of electricity and the development of equilibrium, while the second counteract these changes chemically, and bring the substances back to their original condition, and so keep them constantly in the condition of electrical difference. There is as constantly the attempt to restore equilibrium, and hence so long as these conditions continue there will result this continued series of chemical actions, accompanied by a constant flow of electricity from one substance to the other. In order, however, that this flow of electricity may be thus constant and so constitute a *current* of electricity, as it is termed, there must be a path for a complete circuit or flow in one direction, through the medium which produces the chemical changes, and in the other direction outside of this medium. The substance from which the current flows in the medium is known as the

electro-positive element, and the other the electro-negative. The chemical activity proceeds and the current is formed, in general, at the expense of the electro-positive element.

These operations are illustrated in the ordinary voltaic cell or battery, such as those used for ringing bells, etc. In most of these batteries, however, the action is not self-sustaining, and if allowed to continue for a little time, a condition of electrical equilibrium is reached, or, as ordinarily stated, the battery is run down. In others used for telegraphy and other purposes the operations are self-sustaining and continuous until the chemical substances are exhausted.

In a boiler these conditions for a more or less continued electro-chemical action may be fulfilled in a variety of ways. Parts of the structure of widely differing temperatures or of different physical or chemical compositions may provide the elements in a different electrical condition. Still more likely is such a difference to be found between iron and its oxides, especially the magnetic oxide or mill scale (Fe_3O_4), or between a particle of carbon in the steel and the surrounding metal, or between a place in the steel where the proportion of carbon is much greater than the average and the surrounding metal, or between a bit of slag or other impurity in wrought iron and the surrounding metal. Copper, either in the form of oxide, or especially in the metallic form, would also supply a substance differing strongly from the iron. The exciting liquid is the water in the boiler, and its action will be more vigorous according as it is more acid in reaction, higher in temperature, and denser in concentration. With a high pressure boiler, water of high density and quite acid in character, and with the usual lack of homogenity or uniformity in the structure of the boiler, we should therefore expect the effects of electro-chemical action to be shown in marked degree. It happens, furthermore, that iron is electro-positive to copper, to carbon, and to its own oxides, so that in all cases likely to occur the operation will proceed at the expense of the iron.

From the very nature of these electro-chemical actions their effects are necessarily local in character, and so far as understood they seem to provide a fairly good explanation of the formation of pits as already described. It is not unlikely, however, that in some cases they are due rather to simple chemical action, and that their localization to a small spot is due to special or accidental causes, such as the protection of the surrounding metal by lime scale, or a peculiar weakness against chemical attack at that point, due to peculiarities in chemical or physical structure.

The naval Board of Construction has refused to recommend the purchase of the submarine boat *Holland* by a vote of four to one. Recently a board of survey which examined and tested the boat recommended not only the purchase of this boat by the Navy Department, but the construction of others of the same type.

Reports of the recent trials of the Parsons turbine driven torpedo boat destroyer *Viper*, published in the London *Times*, claim a mean speed of 34.8 knots for four consecutive runs over the measured mile. The fastest run is reported to have been made at the rate of 35 1-2 knots.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XXI.

BY WM. BAXTER, JR.

METHODS OF DISTRIBUTION.—CONTINUED.

In this article we propose to show how to calculate the size of wire for distribution circuits, and also to explain the advantages to be derived from certain arrangements of the connections. Suppose we have a generator that can deliver at its terminals a pressure of 110 volts, then if we connect an incandescent lamp designed for this voltage directly across the terminals it will be traversed by the proper amount of current, and will give the intensity of light at which it is rated. A lamp of this voltage, of 16 candle power, will require a current of about one-half of an ampere, therefore the resistance of it must be 220 ohms, for the e. m. f. is equal to the resistance multiplied by the strength of current, and one-half ampere multiplied by 220 ohms is equal to 110 volts.

Suppose now that we desire to supply another lamp with current, and that this is located 1,000 ft. (this distance is used for convenience of illustration) from the generator, the question is: What size wire must we use to obtain the necessary voltage at this last lamp? In the first place we must observe that it is an impossibility to obtain the full pressure of 110 volts at the distant lamp, but we can come as near to it as is necessary to get an illumination from the lamp practically the same as that of the one connected across the terminals of the machine. To obtain a satisfactory light we must have at the distant lamp a pressure of not less than 105 volts, so that we can lose 5 volts in overcoming the resistance of the line wires. As the lamp is at a distance of 1,000 ft. there will be 2,000 ft. of wire through which the current must pass, and the current strength for one lamp being one-half on an ampere, the resistance of this 2,000 ft. can be 10 ohms, or at the rate of 200 ft. per ohm. Looking at a table of resistances we will find that the nearest number to this is No. 17 B. & S. gauge, which runs about 198 ft. per ohm. Thus we find that to operate one lamp at 1,000 ft. from the generator we will require wires of No. 17 gauge. If we desire to operate ten lamps the current required will be 5 amperes, and then the resistance will have to be reduced to 1 ohm, for the loss of voltage can only be 5 volts, no matter what the number of lamps may be. Looking again at the table of resistances, we will find that No. 7 wire runs about 2,017 ft. per ohm, hence, this is the size wire we require.

Tables that give the diameter of wire for all the gauge numbers, and also the resistance per foot, or the number of feet per ohm, are very numerous and easily obtained from any supply house. Like numerous other things, however, they are not always at hand when we want them, therefore it is well to have some simple rule by means of which we can determine the resistance of a wire if we have no table. If we are provided with a micrometer gauge we can find the resistance very nearly by simply squaring the diameter of the wire, measured in hundredths of an inch, and adding one cipher to the result. As an example, take No. 10 B. & S. wire, the diameter of which is nearly 10.2 hundredths

of an inch, and this number multiplied by itself is equal to 104.04, and by adding one cipher we get 1,040 as the number of feet per ohm. The actual number of feet as given in the table is 1,055, so that the difference is on the safe side. Number 0000 wire is forty-six-hund-

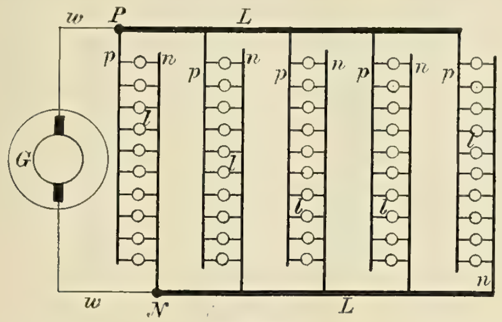

FIG. 134.

redths of an inch diameter, hence 46 × 46=2,116, and by adding one cipher we get 21,160 feet per ohm, and the numbers given in the table are 20,497.

If we are not provided with a micrometer we can still determine the feet per ohm if we know the gauge number of the wire, for the relation between the sizes is such that for every three numbers the cross-section

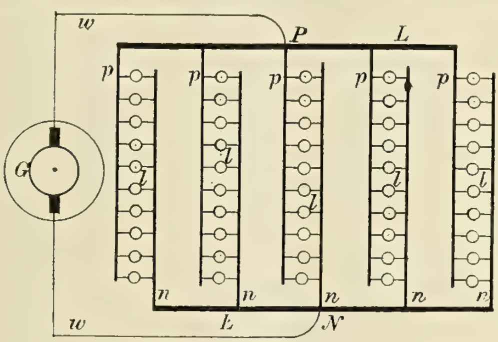

FIG. 135.

is about doubled; hence the number of feet per ohm is doubled, therefore all we have to do is to remember the resistance of three consecutive members, and from this we can determine the feet per ohm of any size. No. 10 wire runs 1,055 feet per ohm; No. 9 runs 1,268 feet, and No. 8 runs 1,600 ft. No. 11 is double the re-

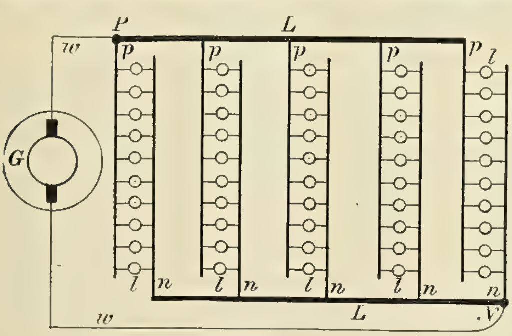

FIG. 136.

sistance of No. 8, or 800 ft. per ohm. No. 13 is double the resistance of No. 10, or 525 feet per ohm, and No. 7 has one-half the resistance of No. 10, or 2,110 ft. per ohm. These figures are not strictly accurate, but near enough for most practical purposes.

Figs. 134 to 138 illustrate different ways in which the lines may be connected, and as will be seen from what follows, they do not all require the same amount of wire to transmit a given amount of current. In Fig. 134 the generator terminals are shown connected with the left hand ends of the line wires *L L*, between which five sets of lamps are connected. As there are ten

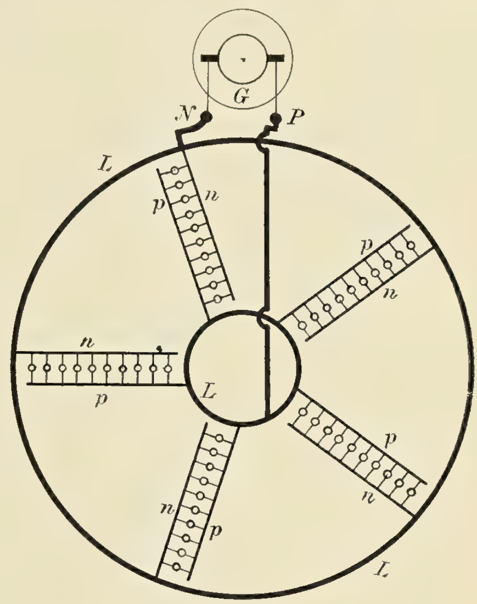

FIG. 137.

lamps in each group the current will be 5 amperes, or 25 amperes for all the lamps. Let the length of lines between the lamp groups be equal, and let the pressure at the generator terminals *P N* be 110 volts; let the resistance of each line *L* be ten-hundredths of an ohm; then, as the first group of lamps takes 5 amperes there will be 20 amperes passing to the second one, and as

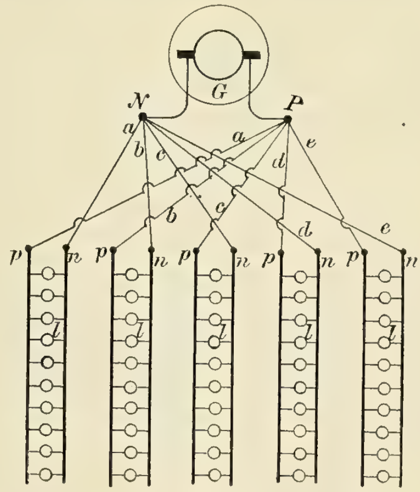

FIG. 138.

one-quarter of the length of each line is traversed before reaching the second group the voltage lost in overcoming the resistance to this point will be 20 amperes multiplied by five-hundredths of an ohm, which is equal to one volt. Thus we find that the e. m. f. at the second set of lamps is 109 volts. The current passing

to the third set of lamps is only 15 amperes, and as the resistance is the same as between the first and second groups the voltage drop will be three-quarters of a volt, therefore, the e. m. f. at the third group will be 108.25 volts. The current passing from the third to the fourth group will be 10 amperes, and the loss of pressure will be one-half of a volt, hence, at the fourth group the e. m. f. will be 107.75 volts. The current passing from the fourth to the last group will be 5 amperes, and the drop of pressure will be one-quarter of a volt, therefore, at the last group of lamps the e. m. f. will be 107.50 volts.

Now let us see what effect the arrangement of the connections shown in Fig. 135 would have upon the loss of voltage. Here the generator terminals are at the center of the mains *L L*, therefore the central, or third group, will receive the full pressure of 110 volts. As 5 amperes of current will pass through this group, there will be 20 amperes left, and this will divide into two equal parts, one of which will flow to the right toward group four, and the other to the left toward group two. These currents being of 10 amperes will lose a pressure of one-half of a volt in passing to the second and fourth groups, as the resistance of the mains between these points is five-hundredths of an ohm. The pressure at the second and fourth groups, therefore, will be 109.5 volts. The current passing from the second to the first group, and from the fourth to the fifth, will be 5 amperes, therefore the drop in pressure will be one-quarter of a volt, thus giving the e. m. f. for the first and last groups equal to 109.25 volts.

In Fig. 134 the voltages of the five groups of lamps are 110, 109, 108.25, 107.75 and 107.50. In Fig. 135, with the same size main feeders *L L*, the voltage at the center group is 110, and at the second and fourth groups it is 109.50, while at the first and fifth it is 109.25. From this it will be seen that if the generator terminals are connected to the center point of the mains *L L*, the drop of voltage will be decidedly less, if the same size wire is used, or, if we do not desire to reduce the drop of pressure we can reduce the size of the mains.

In Fig. 136 the generator terminals are connected with opposite ends of the mains *L L*, as can be seen from the position of *P* and *N*. From *P* the current can pass directly to the first group of lamps, and from *N* it can pass to the last, or fifth group, therefore the number of amperes flowing back from *N* toward the first group will be 20. Of this amount 5 amperes will pass to the fourth group, leaving 15 amperes to pass to the third one. As this last-named group will take 5 amperes, there will be 10 amperes to pass to the second group, and from here 5 amperes will go to the first group. The resistance of each line *L* being ten-hundredths of an ohm, the quarters between the several groups of lamps will have a resistance of two and one-half hundredths of an ohm. Thus the drop of pressure from *N* to the fourth group will be half a volt, and from the fourth to the third group it will be three-eighths of a volt, and from the third to the second one-quarter of a volt, while from the second to the first group the loss will be one-eighth of a volt. Adding all these drops we get 1 1-4 volts drop between *N* and the first group of lamps; hence the pressure delivered to these will be 108.75 volts, and this same voltage will be delivered to the fifth group, for the current passing from *P* to the last group will lose just as much pressure as that passing from *N* to the first group, since both currents are the same.

The current from *P*, that passes to the second group of lamps, is 20 amperes; hence the drop between these points is ½ a volt, but the current passing from *N* to the second group only loses 1⅛ volts, as shown in the last paragraph, therefore the total loss of pressure for the second group is 1⅝ volts, giving the e. m. f. for this group as 108.375 volts. As can be readily seen, this is also the voltage that acts upon the fourth group.

The third group will have a pressure of 108.25 volts, for there will be a drop of ⅞ volt from *P* to the top of this group, and also from *N* to the bottom of it. The loss of pressure with this last arrangement is greater than in Fig. 135, but less than in Fig. 134; hence, for the same loss of pressure the wire would have to be smaller than in the arrangement Fig. 134, but larger than in Fig. 135. In the last figure the pressure of the center group is 110 volts, and that of the end groups is 109.25, thus making a difference of 3-4 volt between the extreme pressures acting upon all the lamps. In Fig. 136 the highest pressure is 108.75 volts, and the lowest 108.375, making the difference between the extremes ⅜ volt, or just one-half as much as with Fig. 135. From this it will be seen that the last figure shows an arrangement that gives a more nearly equal pressure at all the lamps, but it requires a little more wire to keep the total loss of pressure down to the same point.

Fig. 137 represents an arrangement that differs from those shown in the previous figures, in that the mains *L L* form closed loops. If the currents tap into each main at diametrically opposite sides of the diameter we have simply an extension of the plan shown in Fig. 136, while if they cut in on the same side the arrangement amounts to the same thing as Fig. 135. The advantage over both these figures is that if a number of lamps are turned on or off in any group the change in the pressure will not be so great, since the current can reach any group by running around the looped main in either direction, as the case may require.

Fig. 138 shows an arrangement in which each group of lamps is fed directly from the generator terminals. In this case each group receives the same voltage, and as they are all independent, increasing or decreasing the number of lamps in any one group, does not in any way affect those in the other groups.

If we desire to run all the lamps all the time and wish to supply them with as nearly a uniform pressure as possible, but are not particular as to the loss in the transmission lines, then the plan shown in Fig. 136 will give the best results, for with the same amount of wire the difference in voltage at the several groups is the smallest. If the lights are to be turned on and off whenever necessary, the plan of Fig. 135 will be the best, for with it the total loss of pressure is the least with a given size of wire, although the difference between the pressures of the several groups is greater.

A modification of Fig. 138 is shown in Fig. 139, in which feeders are run from the generator terminals to different points along the distributing mains. When this arrangement is used it is possible to deliver a higher voltage to the distant lamp, if so desired, than to

the nearby ones by simply making the feeders *a b c* of different sizes, *c* being larger than *b* and *b* larger than *a*. We can also introduce special regulating devices for the

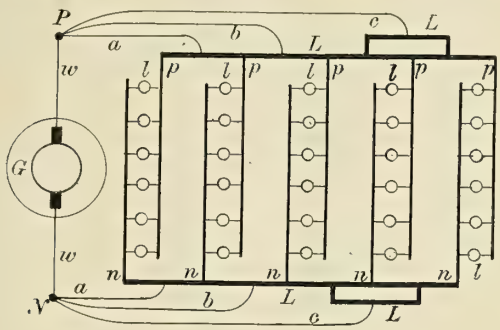

FIG. 139.

purpose of maintaining a uniform pressure, but this part of the subject we will defer to the next article.

POCKET BOOKS FOR 1900.

Fowler's Mechanical Engineers' Pocket Book for the year 1900 has just been issued by the American publishers, D. Van Nostrand Co., New York. This is, we believe, the second year of publication, and the experience gained with the first issue has been used to advantage in making the present issue more complete and useful as a book of reference. The book covers a wide range of subjects, as its name would indicate. An apparent effort has been made to simplify the contents, as far as consistent with a pocket book presentation of the subject; and a feature of the work is the use of explanatory paragraphs throughout in which the present state of knowledge, or the commercial application of it, in each case, is concisely stated. Besides the usual contribution of working formulæ and tables there is a table of properties of saturated steam over a wide range of pressures, from 1 lb. to 300 lbs. absolute pressure. Chapters are devoted to steam boilers and engines, gas and oil engines, locomotives, machine tool work, hydraulics, textile machinery, building, construction, metallurgy, mining, etc. A very considerable amount of space is devoted to electricity, with special reference to electric traction, and there are small chapters on such subjects as chains, springs, acetylene and chemistry. A special chapter on the construction of steamships is written by James Wimshurst, formerly connected with the British Board of Trade. Considering the size of the book, about 500 pages, and the variety of subjects covered, it is well worth the investment of $1 as an addition to the stock of available data on the designer's shelf.

Probably the lowest-priced book issued anywhere for engineers is the Mechanical World Pocket Diary and Year Book for 1900, published by the *Mechanical World*, Manchester, England, price 6 pence. Although published at such a low price, the book is printed in good style. It contains chapters devoted to steam and the steam engine, gas engines, boiler construction—though this refers to tank boilers exclusively—beams and girders, shafting and gearing, belting, electrical transmission of power and hydraulics. There are also included a number of useful tables.

ENGINEERS' DICTIONARY.—XXIV.

Injector—A device for forcing the feed water into a steam boiler. As shown in Fig. 83, it consists essentially of a nozzle, *S*, connected with the upper pipe, *B*, leading steam from the boiler. When the steam is turned on by means of the handle *K*, and attached valve-stem and valve, it escapes in a jet which enters the slightly tapered passage *VC*. The air in the space around and between these two orifices is caught and drawn along with the jet, thus causing a defect of pressure at this point. This space is connected through the lower pipe, *B*, to the water reservoir, and when the loss of pressure is sufficient, the water rises the same as in the case of a pump. The water and steam are thus brought into contact, and pass on together into the combining and delivery tube, *CD*. The steam is here condensed, and the resultant jet of water attains a very high velocity. A little farther on, when this is reduced to the relatively low velocity of the water in the feed pipe, the pressure developed is sufficient to overcome the boiler pressure, to open the check valve, and to force the water into the boiler. While this result may seem puzzling, it may perhaps be an aid to a clearer understanding if we remember that it is the *energy* of the steam which is really the motive power. This is transformed largely into motion in the combined jet, and this, when arrested, gives the pressure as stated before. In a steam pump a steam piston is provided much larger than the water plunger in order to give a force sufficient to overcome the resistance in the feed pipe and at the check valve. So in the injector, in a somewhat similar manner, the energy of the steam in a relatively large pipe is concentrated on a small jet of water, giving it the high velocity and later the pressure as described.

It should be noted that as a boiler feeder a good injector has practically a perfect efficiency, all heat used being carried back again into the boiler, except the small amount lost by radiation from the instrument and connecting pipes.

An injector of the type shown in Fig. 83 is known as an *automatic* injector. This signifies that once the injector is adjusted and working, should the jet of water become broken by a jar or other accidental circumstance,

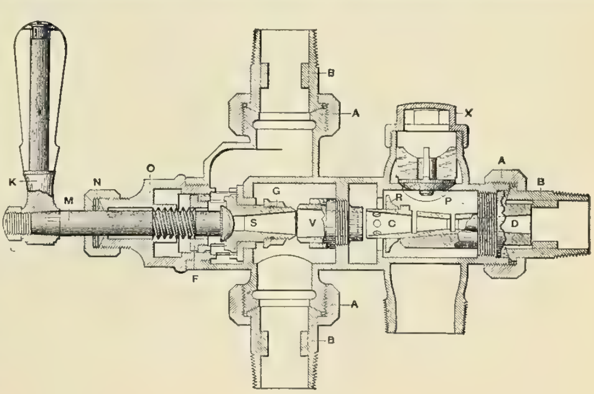

FIG. 83.

it will restart itself without further adjustment. The capacity and working range of an injector are decreased as the lift is higher and as the water is warmer. With cold feed water and a moderate lift, say not exceeding

5 to 8 ft., a good automatic injector will start up with 25 or 30 lbs. steam pressure, and will work with little or no further adjustment over a range of perhaps 100 lbs. pressure. With feed water at about 100° F. the same injector would start at 30 to 35 lbs. steam pressure and will work over a range of perhaps about 70 lbs. or up to about 100 lbs.

In addition to the automatic injector there is another type having two sets of tubes, one for lifting and one for forcing. Such instruments are often termed *inspirators* to mark the distinction from the ordinary automatic injector. When properly adjusted the lifting set of tubes acts as a governor to the forcing set, supplying under a great range of steam pressure the proper amount of water to condense the steam in the final set of tubes. Such an injector, handling cold water with a short lift, will work through a range of over 200 lbs., while with water as hot as 100° and small lift it will work through a range of from 150 to 200 lbs. The operation of each set of tubes is on the same principle as already described for the automatic injector.

Inspirator—See INJECTOR.

Jacket—A space surrounding the cylinder of a steam engine and filled with steam from the boiler. This space is made by the insertion of a shell or liner within the barrel or cylinder proper, leaving a space between the two, as shown under CYLINDER in Fig. 42. The cylinder heads may also be cast with a double shell and space between for the same purpose. The heat from the steam in the jacket is expected to flow through the metal of the liner and to enter the cylinder, thus keeping up the temperature of the working steam and preventing a part, at least, of the condensation which naturally occurs. This is effected to a greater or less extent, and thus one of the losses in the working of steam in a steam engine is reduced in amount. The saving is effected, however, at the expense of the heat thus drawn from the jacket, and the operation is, therefore, an attempt to reduce one loss by introducing another. If the latter is less than the saving in the cylinder the net result will be a gain equal to their difference. If the latter is the greater of the two, the net result will be a loss, and if they are equal the net result will be no change in the economy of the engine. These relations account for the varying experience with jackets, but it now seems well assured that when properly fitted and operated, the result will show a gain of from 5 to 10 per cent over similar conditions unjacketed.

Jacket Drain—A pipe with valves and connections for draining off the water condensed in the jackets.

Jacket Safety Valve—An escape valve fitted to the steam-jacket space, in order to relieve the pressure should it rise to a point considered unsafe.

Jet Condenser—See CONDENSER.

Jet Propeller—A form of propeller consisting essentially of a pump which takes in water from outside the ship and discharges it again with an increased velocity sternward. The propulsive thrust arises from the reaction of the water upon the pump, which produces the change of velocity.

Advices from Glasgow report the commencement of work on the Watson designed steam yacht for James Gordon Bennett, proprietor of the New York *Herald*, at the Denny yard in Dumbarton.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Will you kindly explain the use, construction and care of an evaporator? SUBSCRIBER.

A.—An evaporator is an apparatus for making fresh water to supply the loss in the boiler feed. Of the steam which the boilers supply, not all can find its way back through the feed. Small steam leaks may occur at the various joints, some of the auxiliaries may not send their steam to the condenser, the whistle may be used (as in foggy weather), and so in various ways losses of fresh water will occur. The proportion of such loss varies widely with the circumstances, but will often amount to 5 per cent. and more. In order to avoid making up this loss with salt water, the evaporator is provided.

A representative type of evaporator consists of a series of nests or coils of pipe contained within a chamber—a modern type of evaporator was described and illustrated by drawings in our issue of December last, page 273. The chamber has a salt-feed inlet, and steam from the boiler or from one of the receivers is passed inside the tubes. The heat in the steam passes through the tubes and forms steam or vapor of lower pressure on the salt water side. The chamber is connected with the condenser or with the L. P. receiver, and the steam formed in the evaporator is thus passed into the main circuit and serves to make up the loss as specified before. At the same time the water formed in the coils by the loss of heat is drawn or trapped out as it accumulates and returned to the feed, so that all steam formed on the salt-water side is a net gain for the fresh-water account. The coils on the outer or salt-water side become naturally coated with scale, so that they must be cleaned from time to time. To this end they are usually made removable, or arranged so as to be readily accessible through manhole openings in the shell. It is essential that the tubes be kept clean for efficient working of the evaporator.

In the operation of the evaporator the chief point requiring attention is the proper proportion between the amount and temperature of the inflowing steam and the pressure within the chamber on the salt-water side. If the pressure is low and steam is provided in excess, it may give rise to a violent ebullition or foaming which will carry some of the salt water along with the vapor formed, and thus introduce salt instead of fresh water into the circulating system. This condition must be guarded against by a proper control of the amount of steam admitted. In the way of general maintenance the condition of the tubes as regards scale is the chief point requiring attention and, of course, the tightness of the tube joints.

Q.—What has produced the best results on ships' bottoms in reducing water friction or adhesion thereon? R. J. K.

A.—Smooth polished copper or sheathing metal, an alloy rich in copper, has produced the best results in reducing skin resistance or drag between the surface of a ship and the water. There has been but little information on this subject published of late, and no records of tests of recent date, but it is safe to consider that among the various materials available for the covering of ships' bottoms, none is superior to copper sheathing. This form of covering may always be applied to wood hulls, but cannot be directly applied to iron or steel on account of the electro-chemical action which would result, accompanied by the serious corrosion of the metal of the ship. To avoid this the well-known custom of "sheathing" with wood first and then with copper is sometimes adopted, especially for naval ships which are to make long cruises without opportunity for docking, cleaning, and repainting.

For iron and steel hulls various paints are used, the points of superiority depending chiefly on the ability to adhere closely to the metal and thus furnish the protection required, and the property of poisoning or preventing the growth of the various forms of marine life which are liable to attach themselves to ships' bottoms. Various so-called "copper" paints or other special protective and anti-fouling compositions seem to have given fairly satisfactory results, but no form of painted surface will long retain its original smoothness, and at intervals, longer or shorter according to circumstances, the ship must be docked and the bottom repainted. At best the painted surface is inferior to copper sheathing, the difference ranging from 5 to 10 per cent. according to various tests.

MARINE ENGINEERING.

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GROUP OF SIX 31-KNOT YARROW DESTROYERS FOR THE JAPANESE NAVY.

Japan has made such extraordinary progress in naval matters in a very few years that she can now be accurately classed as a first-rate naval power. In modern vessels of every type she can make a respectable showing, from half a dozen battleships afloat (none older than 1896, and ranging in size from 12,300 tons to 15,200 tons) down to torpedo boats of the most modern type. Her experiences in the war with China have been put to good use in the design of vessels for her special needs.

Among the latest additions to her navy is a group of six torpedo boat destroyers, each having a trial speed in excess of 31 knots. These boats were constructed at the Poplar yard of Yarrow & Co., the well-known English torpedo craft builders, and the last of the six, the *Niji*, is shown in the frontispiece, steaming at sea. These six vessels are practically uniform in construction, and on trial gave very similar and highly successful results. Their dimensions are:

JAPANESE TORPEDO BOAT DESTROYER NIJI—311 TONS, 31 + KNOTS—STEAMING AT REDUCED SPEED.

Length, 220 ft. 3 in.; beam, 20 ft. 6 in.; draft, 5 ft.; displacement, 311 tons. Their armament consists of one 12-pounder and five 6-pounder rapid firers, and two 18-in. torpedo tubes, with six automobile torpedoes. A coal capacity of 90 tons is provided, which gives a low speed steaming radius of 3,000 nautical miles.

The first of these vessels was begun in January, 1897, and the last completed her acceptance trials in January of this year. They are the largest vessels of this type yet turned out by this builder.

All six of the boats are twin screw, fitted with triple expansion four cylinder engines, having cylinders, H. P. 20 1-2 in. dia., I. P. 31 1-2 in. dia., and two L. P. 34 in. dia., and 18 in. stroke. The engines were designed for 6,000 I. H. P., but could be forced considerably above this without distress. They are balanced on the Yarrow-Schlick-Tweedy system, with the low pressure cylinders at the forward and after ends of each engine, and when running are reported to have produced comparatively little vibration. Three-bladed propellers are used. There are four boilers in each of the boats, two for each engine. A separate funnel is fitted for each boiler, and there are two stokeholds, the two middle boilers being placed back to back. Each boiler is of the Yarrow express water tube type*, with straight tubes, and is of large dimensions, having a capacity of 1,600 horse power. With water and fittings each boiler weighed 18 tons. Coal bunkers are situated at the sides of the vessel. Two fans (horizontal), 6 ft. dia., are fitted in each boat, or one fan to two boilers.

Conditions of trial were a speed of 31 knots, with a load of 35 tons on a three hours' continuous run. The trial of the *Niji* was conducted under the supervision of Rear-Admiral H. Kamimura, Chief of the Japanese Naval Commission, and other high officials of the Japanese Navy. On trial the draft of water to the bottom of the propellers was 7 ft. 10 in. aft and 4 ft. 11 in. forward. Observations taken during the three hours' trial gave the following means: Boiler pressure, 204 lb.; first receiver, 53 lb.; second receiver, 7 lb.; vacuum, 23 3-4 in.; air pressure in stokehold, 3-4 in. to 7-8 in.; revolutions per minute, 388.06, and speed, 31.156 knots.

Of all six boats the fastest on trial was the *Sazanami*, with 31.382 knots, and the slowest the *Inadsuma*, 31.037 knots, truly a remarkable showing. One boat of the group, the *Akebono*, was launched only nine days before the official trial, and had only one preliminary run before the trial took place.

Concurrently with the construction of these destroyers more than a dozen others of lesser size and speed were built at other yards in England, France, and Germany for the Japanese Government.

To supply the demand for efficient deck officers in its service, the North German Lloyd Co. has now under consideration the equipment of a sailing ship as a school ship for youths who intend to enter the service of the company. The intention is to establish a three years' course, in which practical seamanship will be taught by the master and officers, and theoretical instruction will be given by a college graduate.

*An illustrated description of one of these boilers was published in our issue of November, 1899, page 225.

STEAMSHIP LINES OF THE PACIFIC COAST—PRESENT FACILITIES AND PROBABLE FUTURE GROWTH.

BY D. S. KIMBALL.

The Pacific coast, unlike the Atlantic, has but a few good harbors, so that one terminal of all the American steamship lines doing business on the Pacific, either coastwise or foreign, is found at San Francisco, Portland, or one of the Puget Sound ports.

When the rush for the gold fields of California began, transcontinental railways had not been thought of, and the water route by the way of Panama offered the only immediate and easy solution of the transportation problem. A line of steamships was at once put on between New York and San Francisco, and the latter port became the Pacific terminus of the first steamship company running to the coast.

California filled up much more rapidly than any other portion of the coast, and San Francisco, having the only harbor for hundreds of miles in either direction, soon became the distributing point for the whole western slope. When the Central Pacific Railroad was built, her position was strengthened still more, and she held undisputed sway as the central point of transportation and distribution until a few years ago, when transcontinental railways across the northern portion of the continent compelled her to share the honors somewhat with the ports farther north. This, of course, did not result in a falling off of San Francisco's trade, but rather in a more independent growth of the northern section of the coast. And while this latter has been rapid, in common with the growth of the whole coast, San Francisco, backed by the great natural resources of California, has kept in the lead as a shipping port, and is still the center of the largest steamer and sailing trade on the coast.

The principal steamship companies operating ocean steamers from San Francisco as a terminus are the Pacific Mail Steamship Co., the Oriental and Occidental Steamship Co., the Oceanic Steamship Co., and the Pacific Coast Steamship Co. Besides, it is the eastern terminal of the Toyo, Kisen Kaisha, a Japanese company with headquarters at Tokio, Japan.

The Pacific Mail Steamship Co. is by far the largest of these corporations, and is the pioneer line of the Pacific. This company operates seventeen steamers, coastwise or foreign, of from 1,500 to 5,000 tons, with a total tonnage of 49,000 tons. The transpacific fleet consists of four ships, the *China*, *City of Pekin*, *City of Rio de Janeiro*, and the *Peru*. The first two are of 5,000 tons, and the last of 3,500 tons each. The first three, while not new boats, are well fitted up and very comfortable. The *Peru* is of more recent construction, having been built by the Union Iron Works, about eight years ago.

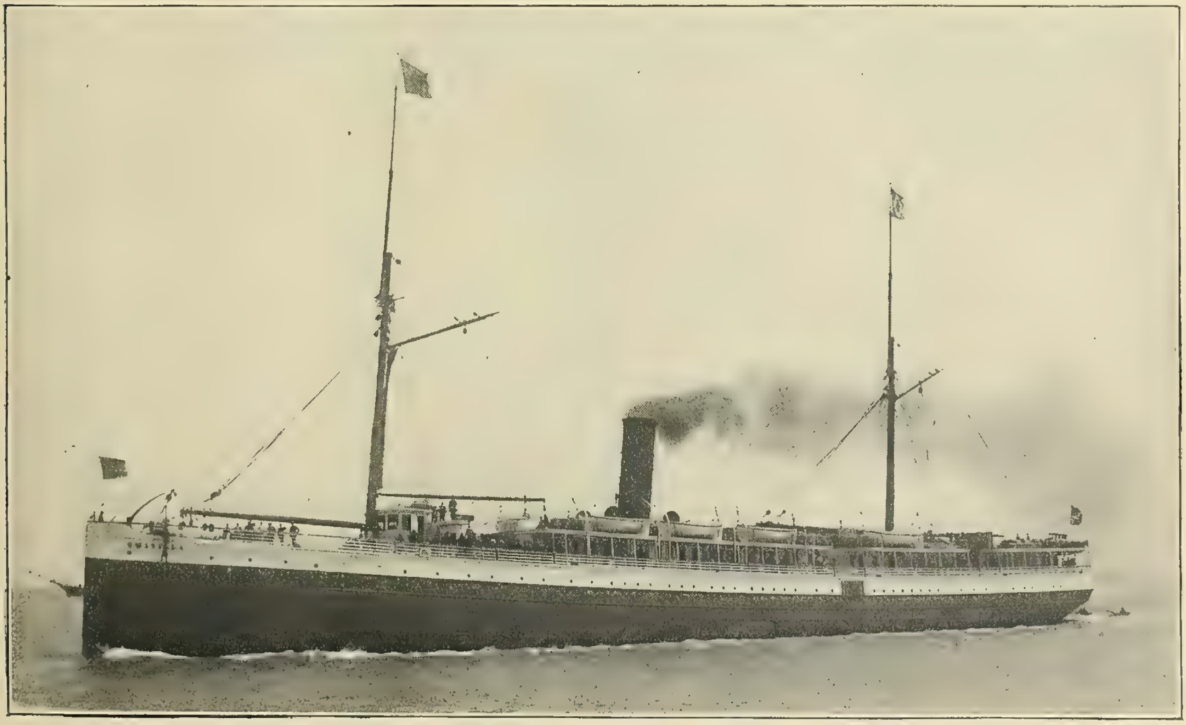
These steamers sail between San Francisco and Hong Kong, touching at Honolulu, Yokohama, Kobe, Nagasaki, and Shanghai, connections being made at the various Asiatic ports with steamers for all places in the Orient, as well as for Europe, via the Suez Canal.

This company has now under construction at the Newport News Shipyard two vessels of about 12,000 tons gross, of these dimensions: Length over all, 575

PACIFIC COAST STEAMSHIP CO.'S S. S. SANTA ROSA—326 FT. LONG, 2,417 GROSS TONS.

ft.; between perpendiculars, 550 ft., and depth, 40 ft. They will have all modern improvements, and will carry a large number of passengers of all classes. They will have quadruple expansion engines, with cylinders, 35 in., 50 in., 70 in., and 100 in. dia., and 66 in. stroke, and are designed to develop about 18,000 collective horse power. It was recently reported also that this company had purchased a steamer of large freight capacity, built abroad.

The coastwise fleet consists of thirteen steamers of from 1,500 to 3,000 tons. They are all of iron and steel, and, like the larger steamers of the company, while not new, are comfortably fitted up. These steamers ply between San Francisco and the principal ports in Mexico



PACIFIC COAST STEAMSHIP CO.'S S. S. UMATILLA—310 FT. LONG, 3,000 GROSS TONS.

and Central America, the southern terminus being Panama, where connections are made with steamers for the west coast of South America, and, by means of the Panama Railroad, with steamers for Europe and the east coast of America.

The Oriental and Occidental Steamship Co. also run a line of four steamers to the Orient on the same route as the Pacific Mail Steamship Co. These steamers, the *Belgic, Coptic, Gaelic* and *Doric*, are not new vessels, having been built several years ago at Harlan and Wolf's yard at Belfast, Ireland. They are, however, luxuriously fitted up, and are of modern construction, having eight water tight bulkheads. The four ships do not differ much one from the other, each being about 430 ft. long, of 4,500 tons, and built along the same lines.

That the Japanese have an eye to the future traffic across the Pacific, is shown by the two steamer lines which they already have running to America. One of these, the Toyo Kisen Kaisha, already mentioned, put on three new steel steamers between San Francisco and the Orient about a year ago. These ships, the *Nippon Maru, America Maru,* and *Hong-Kong Maru,* are sister ships, built in England. They are 440 ft. long, and have a gross tonnage of 6,000 tons. They have twin screws, driven by independent engines, with cylinders 28 in., 46 in., and 75 in. dia., by 48 in. stroke. They are first-class ships in all respects, and were built to conform to Lloyd's rules.

These three steamship lines—the Pacific Mail, Oriental and Occidental, and Toyo Kisen Kaisha—operate on a joint schedule whereby a steamer of some one of the companies sails from San Francisco for the Orient every eight days, all steamers traversing the route as given above, for the Pacific Mail Steamship Co.'s vessels. Considering the distance traveled, this makes good service. All these ships touch at Honolulu both ways.

The Oceanic Steamship Co. operates the only line running regularly to Australia. This company has four steamers of from 3,000 to 3,500 tons, two of which, the *Alameda* and *Mariposa,* are of American build, and while about sixteen years old, are good ships. The *Alameda* lately completed one million miles without a serious mishap, which is certainly a good record. Twice a month steamers of this company sail from San Francisco for Honolulu, and every twenty-eight days for Australia. Next season this company expects to have in commission on this route three new steel ships, now building, of 6,000 tons each.

A comparison of the distances traversed by these Pacific steamers and the time consumed in doing so, with the distances covered and times consumed by the Atlantic liners, may be of interest. Some of the distances on the Pacific seem rather great by comparison.

From	San Francisco	to Honolulu,	2,089	miles.
"	Honolulu	" Yokohoma,	3,445	"
"	Yokohoma	" Hong-Kong,	1,490	"
"	San Francisco	" Hong-Kong,	6,381	"
"	" "	" Sydney,	6.514	"
"	" "	" Panama,	3,277	"

The trip from San Francisco to Honolulu is made in about six days, or about the same time consumed by the Atlantic liners in going from New York to Liverpool, a distance of about 3,100 miles.

The total number of regular passenger steamers running out of San Francisco to foreign ports at the beginning of the year 1899 was twenty-eight, with a total tonnage of 98,000. Besides which there is a great freight traffic to all parts of the world, the number of steamships arriving from foreign and Atlantic ports during the year 1898 being 330, with a net tonnage of 592,865 tons. The total number of sailing vessels arriving from foreign and Atlantic ports during the same was 494, with a total tonnage of 530,092 tons.

A steamship company recently organized to engage in Hawaiian trade has now under construction in this country four large vessels of these dimensions: Length over all, 430 ft.; beam, 50 ft.; depth, 34 ft. They will be single screw vessels, with engines of about 2,500 I. H. P., and carrying 8,250 tons dead weight, will have a sea speed of about 10 knots.

San Francisco is also the center of a large coast trade. As yet few railroads connect coast ports, so that a great part of the trade is by steamer, and many companies are engaged in it. By far the largest is the Pacific Coast Steamship Co., which operates twenty passenger steamers, ranging in size from 300 to 3,000 tons, with a total tonnage of 32,000 tons. This company runs steamers to all coast ports from Alaska to Mexico.

The passenger trade between Portland, Ore., and San Francisco by steamer is controlled by the Oregon Railway and Navigation Co., which operates steamers of about 3,000 tons between these ports.

There are also many small companies engaged in coastwise trade, much of which is carried on in steam schooners, peculiarly adapted to the requirements of the traffic, a great deal of which is in lumber.

San Francisco's greatest rivals in the ocean trade will no doubt be the ports on Puget Sound. This beautiful inland sea is one great harbor in itself, having an area of nearly 2,000 square miles, broken up into a maze of bays and inlets, and offering the finest facilities possible for navigation by steamer. There is an abundant depth of water, so that the size of vessels trading to these ports will not be limited by harbor obstructions. Puget Sound is backed by a fine farming country, and already three trans-continental railways have terminals on its shores. Its ports will surely be strong competitors in the race for the commerce of the Orient.

The principal shipping points on the Sound are Seattle and Tacoma. From the latter the Northern Pacific Steamship Co. operates, in connection with the Northern Pacific Railroad, a line of four steamers of from 2,600 to 5,300 tons to the Orient They run as far as Hong-Kong, stopping at Victoria, B. C.; Yokohama, and Kobe.

The same company have lately put in operation a line of three steamers from Portland, Ore., to the same Oriental ports. None of these ships are new, having seen service in other waters; one, the *Arizona*,* was the original Atlantic greyhound. A number of the vessels of this company are now doing transport service to the Philippine Islands.

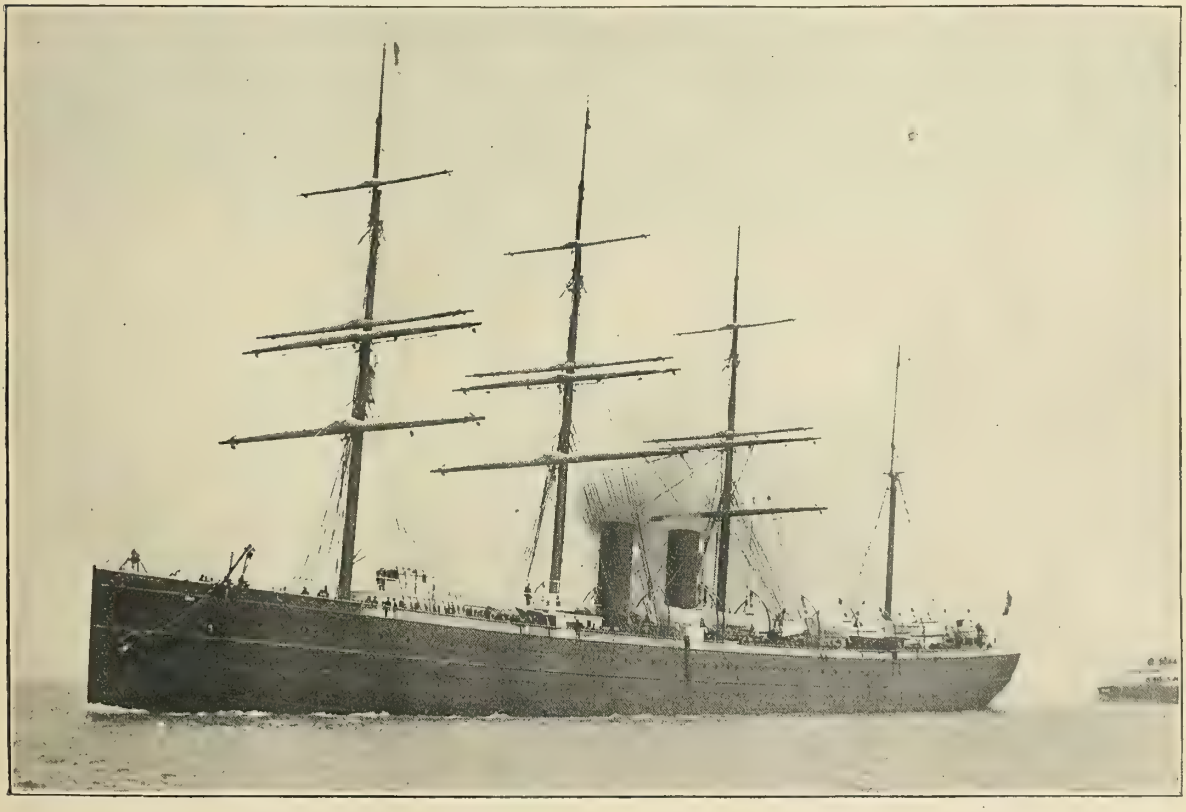
Seattle is the American terminus of the other Japanese line before mentioned. This is the Nippon Yusen Kaisha (Japanese Mail Steamship Co.), which runs in connection with the Great Northern Railroad. At pres-

*An extensive description of this vessel illustrated by photographs was published in our issue of September, 1898.

OCCIDENTAL & ORIENTAL STEAMSHIP CO.'S S. S. COPTIC—430 FT. LONG, 4350 GROSS TONS.

ent three steamers of from 3,200 to 4,700 tons are employed sailing monthly only from Seattle. These steamers are of the combination cargo and passenger type, having accommodation for only a few first class passengers. It is the intention of the Nippon Yusen Kaisha to replace them with new and first-class ships in the near future. Incidentally it may be of interest to note that this company is one of the largest steamship companies in the world, operating altogether a fleet of 70 ocean steamships, varying in tonnage from 3,000 to 7,000 tons and having a total tonnage of 200,000 tons. The company also owns a large fleet of small coast steamers, and has headquarters in Tokio, Japan.

A new steamship line from Seattle to the Orient is projected by J. J. Hill, president of the Great Northern Railway. According to the announced plan of the promoters, the vessels for this service will be of enormous carrying capacity, with low power, so that bulk cargoes,



PACIFIC MAIL STEAMSHIP CO.'S. S. S. PEKING—427 FT. LONG, 5,000 GROSS TONS.

chiefly of grain, can be delivered at Asiatic ports at a minimum of cost.

A large foreign trade is being built up at the Sound ports, the greater part of which is in lumber, the chief article of export of Washington. While some steamers are used in this trade, by far the greater part is carried on in sailing vessels. But at the principal ports, as Seattle and Tacoma, there is a considerable steamship trade. Large quantities of flour and grain are shipped to European and Oriental ports. Many such cargoes are taken out in steamers, nearly all of which are, unfortunately, of foreign build. The import trade from China and Japan by steamer is already very large, consisting mainly of tea, silk and rice, but these commodities do not, of course, furnish cargo to fill all the large vessels on their return trips. An effort is being made to develop a trade in minerals, and now there are some shipments of ore from the Orient as return cargoes. A small steamer trade has lately been established with Honolulu.

The steamer coasting trade from Puget Sound ports is large, and growing rapidly. The coal mines of Washington produce 2,000,000 tons annually. About one third of this is shipped—a large proportion in steam vessels—to different coast ports, particularly those of California. The recent mining developments in Alaska have also resulted in a great increase of the tonnage in that trade. Now, several regular steamship lines are running to Alaskan ports from Seattle or Tacoma, as well as from Portland and San Francisco.

During last summer no fewer than sixteen steamers of from 1,000 to 2,500 tons were making regular trips to Alaska, starting from or touching at Seattle. The passenger end of the traffic is quite considerable. Whether or not this trade will be permanent depends upon the future development of mining in the Klondike region, at Cape Nome, and at other points. The lumber trade is handled almost entirely by sailing ships, as far as coast trade is concerned, although farther down the coast small steamers are used very successfully.

The local trade in Puget Sound will always be carried on to a large extent by steamers. Perhaps no other section of country in the world has such a water privilege as the country surrounding the Sound. From the sea to its headquarters, a distance of 200 miles, there is neither shoal, reef or hidden danger to be found; and while only 200 miles long, its shore line is 1,600 miles in length. This gives some idea of its irregular form, and all these land-locked waters are navigable. Communication by steamer will always be much quicker, easier and cheaper, between most points, and the waters even now are full of small craft. The total number of steamboat lines entering Seattle in 1899 was 33. Many of these, of course, were small lines, and many lines consisted of one steamer only. The local inspectors at Seattle examined 358 steamers in 1898, a considerable fleet for a new country. The conditions are ideal for steamboating, as no violent storms prevail, shipwrecks from natural causes are unknown, and many fast steamers are to be found here, as it is possible to reduce the beam to a minimum on these peaceful waters. A trip from Seattle to Tacoma on the well named *Flyer* is really a pleasant experience. An abundance of wood and coal is at hand and seems to complete the list of requirements for good steamboating.

C RAILWAY S. S. EMPRESS OF JAPAN—455 FT. LONG, 5,900 GROSS TONS.

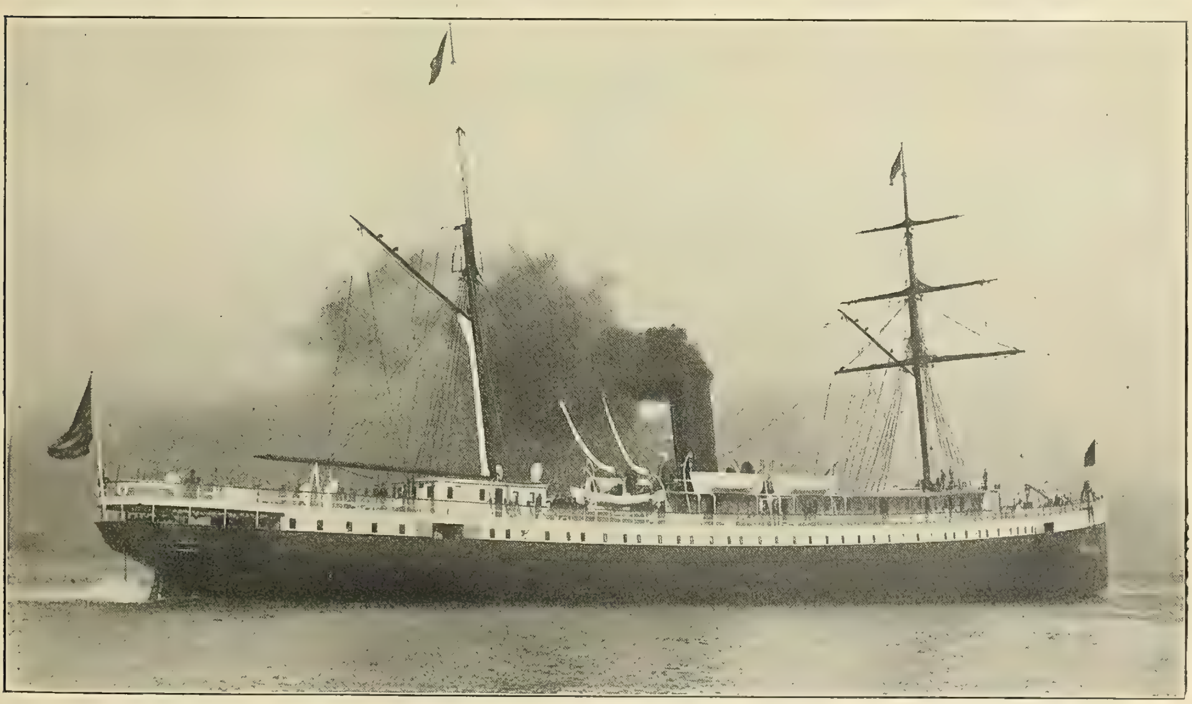
Crossing over into British Columbia similar conditions are found to prevail. Most of the coast and local traffic is done by steamer, while the Canadian Pacific Railroad has the finest line of steamships sailing from the Pacific coast to the Orient. These steamships, *Empress of India*, *Empress of Japan*, and *Empress of China*, are 458 ft. long, 6,000 tons gross tonnage, and can steam 18 miles an hour. They have twin screws, driven by independent engines of 5,000 horse power each, and are first-class ships. They were built in England in 1891.

The same company also operates a line of three steamships of 3,500 tons to Australia and New Zealand, touching at Honolulu and the Fiji Islands. The Amer-

NIPPON YUSEN KAISHA (JAPAN MAIL STEAMSHIP CO.) S. S. TOSA MARU—445 FT. LONG, 5,794 GROSS TONS.

ican terminus is Vancouver, B. C., which is also the western terminus of the Canadian Pacific Railroad.

The outlook for marine engineering on the Pacific is most encouraging. Up to the present time a rather inferior class of ship has been in use, on the whole, and these waters have been used a good deal as a dumping ground for ships that have outgrown their usefulness elsewhere. But the demand is rapidly growing for new and fast ships, and the recent developments in the far east will soon make such vessels an absolute necessity. There is sure to be a great trade across the Pacific before many years, and, while it may not be possible, financially, to operate vessels over such a great distance with the speed of the Atlantic liners, a great improvement over those now in use must soon be made. The distance from Liverpool to Hong Kong via San



OCEANIC STEAMSHIP CO.'S S. S MARIPOSA—320 FT. LONG, 3,150 GROSS TONS.

Francisco is about 14,000 miles, or a little more than half way round the globe. At present thirty-nine days are required for a continuous trip by this route. Twenty-eight days are consumed in the trans-Pacific portion of the journey, considerable time being lost in stops at intermediate ports. The Canadian Pacific steamers do better in point of time, the *Empress of Japan* having made the run from Vancouver to Hong Kong in 17 1-2 days including stops at the regular way ports. This would make the total time of a continuous trip from Liverpool to Hong Kong about 29 days. The run from Vancouver to Yokahama was made in 10 1-2 days, and the distance is 4,500 miles.

The Pacific route from Europe to China is more direct than the one by the way of the Suez Canal, and good service on the Pacific would make it the quickest and most desirable way.

A great many of the coasting steamers have been built at the different yards on the Pacific coast. As yet few large ocean liners have been constructed, although some of the yards have facilities for building large vessels, one, the Union Iron Works, being too well known to need further comment. There is no doubt but that as the demand for larger and better vessels increases, the facilities for constructing such vessels on the coast will keep step with this progress. All the coast yards are at present handicapped by having to bring their iron and coal from a distance. Iron mines have been found and worked to a small extent. Anthracite coal has been located, but not in any quantity. The country, however, is still in a measure unexplored, and the finding and developing of good iron mines would give steel shipbuilding and marine engineering a great impetus. The greater part of the small coasting steamers are, of course, now constructed of wood, the forests of Washington and Oregon furnishing an unlimited supply of the finest shipbuilding timber to be found anywhere the world over.

NOTES ON SHEATHING U S. NAVAL ACADEMY PRACTICE SHIP CHESAPEAKE.*

BY NAVAL CONSTRUCTOR LLOYD BANKSON, U. S. N.

The sheathing of steel vessels with wood being rather a new subject in this country, from a practical point of view, it is proposed to describe the process of sheathing the *Chesapeake*,[1] the practice ship for the U. S. Naval Academy, built by the Bath Iron Works, of Bath, Maine, from designs furnished by the Bureau of Construction and Repair.

The plans were described in the preceding volume of the transactions of this Society. The ship was launched June 20, 1899, the keel having been laid August 2, 1898.

The specifications for sheathing were, briefly, as follows:

"The wood keel to be of East India teak; to be well secured to the keel plate with brass screw bolts 1 3-8 in. dia.; the false keel to be of white oak 3 in. thick and in lengths not exceeding 12 ft., and fastened to the main keel with composition spikes.

"The planking to extend from the keel to about 26 in. above the water-line amidships, to sheer up 15 in. forward and 12 in. aft. To be of Georgia pine throughout, the upper edge to be covered by an angle 3 in. by 3 in. by 7 lb. per foot. Planking to be worked in one thickness of 4 in. The two top strakes and the planking near the stem and stern-post to be reduced in thickness from 4 in. to 3 1-2 in.

"The garboards to be cross bolted through the top of the keel with 3-4 in. copper bolts. The plank on the bottom to be about 9 in. wide amidships and on the sides about 8 in., tapering forward and aft as may be necessary to make fair work.

"The plank to be fastened with 3-4 in. naval brass screw bolts screwed through the plating between the frames, and to have brass nuts on the inside on iron washers."

The foregoing were the principal requirements in regard to planking and fastening. Several important points came up as soon as the work began, the principal one was in regard to marking off and boring the holes in the planks for the bolts. It was found that most of the planking had to be steamed in order to make a good job in bending it to fit the plating. In doing this it was decided that it was not practicable to mark the holes on the plank from the inside of the ship and then take the plank down again to bore the holes square with the inside surface of the planking. (According to the specifications the holes were required to be drilled in the plating first.)

The work was done as follows: The holes were bored through the planking from the outside after it was secured in place, Fig. 1. After carefully boring the holes from the outside slightly smaller than the diameter of the bolt, the drilling and tapping of the bottom and side plating was done through the holes in the planking, and finally the outer ends of the holes in the planking were counterbored with a plug auger to take the heads of the bolts.

The drilling and tapping of the plates was done both by hand and by pneumatic power. The bolts were fitted in place as follows: A hemp grommet being first put under the head of each bolt with a proper amount of red-lead putty, the bolt was then screwed into the bottom plating through the wood planking and well hove up until the putty was squeezed out around the head of the bolt. A special gang followed the work from the inside of the ship and fitted the washers and nuts. The wrenches used were about one foot long, and in two or three cases the bolts were twisted off. It is thought that a wrench about 8 in. long should be used for 3-4 in. bolts. Various means were tried for heaving up on the bolts from the outside—hand ratchets, hand braces and pneumatic braces. The pneumatic tool was rapid and seemed to do its work well. It was found on examination that with very few exceptions the bolts were square with the inside surface of the plates.

Before fitting the plank in place against the steel plating the hull was carefully tested for water-tightness and all leaks stopped. The skin plating having been originally pickled, it was carefully cleaned and a thick coat of a mixture of white and red lead put on the plating, as well as on the faying surfaces, when each plank was fitted in place. The outside plating was

*Read at the seventh general meet'ng of the Society of Naval Architects and Marine Engineers, held in New York.

[1]For a complete description of this vessel, see MARINE ENGINEERING, Vol. IV, page 168.—Ed. M. E.

fitted in the usual manner with inside and outside strakes. The garboard strakes and sheer strakes were of 17 1-2 lb. plating and the balance 15 lb. plating.

The method of holding the plank in place is shown in. Fig. 1. Great care was taken to have the planking beveled so as to leave a good 1-4 in. seam for caulking in order to avoid the use of the reeming iron. The butts of the planking were specified to fall between the frames, and nearly all were butted as specified. The fastening was well done and the quality of the bolts good. Table I shows the results of tests made as the work progressed.

The specifications required that the bolts were to be made of naval brass, composed of 62 parts of best selected copper, 37 parts of Silesian zinc, and 1 part of tin. The brass bolts to be capable of being bent cold to an angle of 40 deg., when screwed, without cracking or fracture, and to have a tensile strength of 42,500 lb. to the sq. in. The mean of the means of 21 test pieces gave an average tensile strength of 47,204 lb. per sq. in.

Test pieces 1, 2 and 3 (Table I) show the result of using ordinary casting copper and green sand moulds. All other test pieces and all bolts used on the *Chesapeake* were made of tin, Lake copper, and American zinc, and cast in iron moulds. The results may be considered good.

Fig. 2 shows photograph taken of various blank and finished bolts as the work progressed. Exhibit *H*, Fig. 2, shows a finished 1 3-8 in. keel bolt bent with a 14 lb. sledge, the bolt being held firmly in an 8 in. timber and struck on the head. Not a mark or crack showed on the finished surface of the bolt. Exhibit *C* shows a rough blank 3-4 in. bolt taken at random and bent. *D* and *E* are two finished 3-4 in. bolts taken at random and bent; *D* cracked and *E* broke off completely. No. 18 (see Table I) was pulled in a testing machine and broke squarely with a clean fracture. Exhibit *B* represents one of the blank nuts drifted with a pin until it cracked. *A* represents the original size of the blank.

The specifications called for the bolt heads to be covered with Portland cement in the countersink to insure water-tightness. This was done. After the bolts were hove up in place, and the washers and nuts put on and properly hove up, the points of the bolts were center-punched in three places at the top of each nut by special men, to prevent the accidental turning of the nuts and to show that they had been hove up by the proper persons.

The specifications required the caulking to be done in a very careful manner, in order not to strain the fastenings, and the use of the reeming iron was forbidden The seam required was to be between 1-4 in. and 5-16 in. for a 4 in. plank, and other thicknesses in proportion.

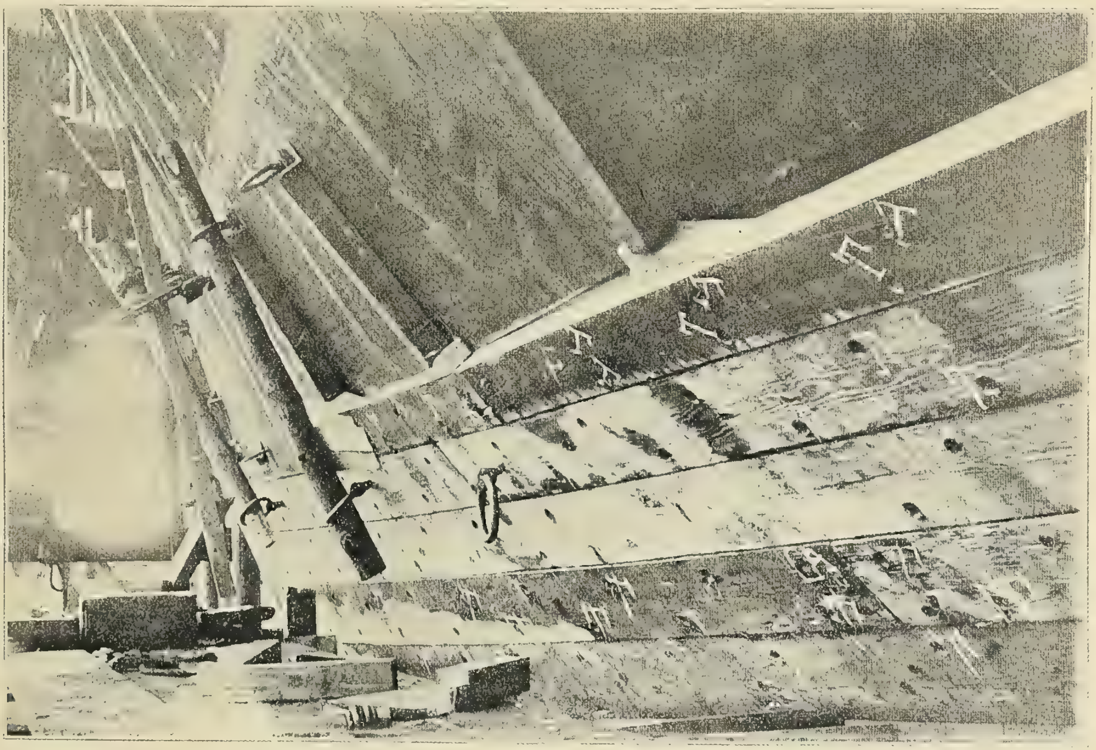


FIG. 1.—METHOD OF HOLDING PLANKING IN PLACE.

Ten threads were required in each seam, and they were driven as follows:—Four threads of oakum were driven into the seams by hand mallet and iron, and these threads were then forced home with horsing-iron and beetle. The first four threads were then followed by three additional threads, driven by hand mallet and iron and then horsed against the first four with iron and beetle.

The seams were then filled up with three threads and properly horsed as before. The outside surface of the oakum, after horsing the seams and dubbing the planking, was about 3-8 in. beyond the surface of the plank. The seams were then payed with hot pitch put on with a mop. A mixture, by weight, of 63.57 per cent. of

white lead, 32.10 per cent. of dry lead, and 4.32 per cent. of linseed oil, was used to fill up the interstices between the inside surface of the planking and the outside surface of the steel hull.

Holes were bored at intervals of about 8 ft. in the center of each plank, and the mixture forced in by about 50 lb. of putty, the smaller size holding about 10 lb.

The amount of putty injected is shown on the list of weights. A comparatively small quantity was required, except in a few places, the planking having been fitted quite snugly to the steel plating. The injected putty

TABLE I.—TESTS OF NAVAL BRASS FOR SHEATHING BOLTS—U. S. S. CHESAPEAKE.

No.	Date of test	Diam. of test piece.	Elastic limit per sq. inch.	Ultimate tensile strength per sq in.	Elongation.		Reduction of area.	Fracture.	Remarks.
1	....	1."025	....	27,593	in 8"	7.8%	V'y slight.	Not homogeneous.	Cast in green sand moulds. Ordinary casting copper used.
2	....	1."025	....	26,535	in 8"	6.25	do.		
3	....	1."025	....	22,345	in 8"	3.9	do.		
	Means........	....	....	25,491	....	5.98			
4	Oct. 25, 1898.	1"	....	46,626	in 2"	21.87	23.44%	Fine and homogen's	Cast in iron moulds. Allowance made for cavities.
5		1"	....	51,190	in 2"	25.00	23.44	Do	
6		1"	....	46,301	in 2"	18.75	23.44	Two small cavities	
7		3/4"	....	45,766	in 2"	14.06	15.96	Not quite homogen's	
	Means........	....	....	47,471	....	19.92	21.57		
8	Dec. 13, 1898.	1"	....	45,651	in 3"	19.8	33	Two cavities........	Allowance made for cavities. Cast in iron moulds.
9		1"	....	45,836	in 3"	27,1	33	Slightly porous	
	Means........	....	....	45,743	....	23.45	33		
10	....	1"	....	42,585	in 6"	13.54	23.44	Cavity........	Allowance made for cavity. Cast in iron moulds.
11	....	1"	....	42,842	in 6"	15.63	23.44	Cavity........	
	Means........	....	....	42,713	....	14.58	23.44		
12	Jan 7, 1899 ..	7/8"	....	54,049	in 2"	37.5	26.5	Normal	Allowance made for cavities. Cast in iron moulds. Rapid feed used in testing.
13		7/8"	....	48,827	in 2"	37.5	26.5	Slightly porous	
14		7/8"	....	50,203	in 2"	28.1	26.5	Normal........	
15		7/8"	....	49,409	in 2"	28.1	26.5	Cavity........	
	Means........	....	....	50,622	....	32.8	26.5		
16	Apl. 12, 1899.	3/4"	....	55,268	in 2"	27.0	30	Normal	Cast in iron moulds. Slow feed used in testing machine.
17		3/4"	....	56,305	in 2"	37.0	30	Normal........	
	Means........	....	....	55,786	....	32.0	30		
18	Apl. 26, 1899........	1/2"	....	46,627	....	....	....	Normal........	Slow feed used. 3/4" bolt and nut. Bolt cast in iron mould.
19	May 4, 1899...	1/2"	....	45,568	in 2"	31.25	34	Normal........	Cast in iron moulds. Slow feed used in testing.
20		1/2"	....	43,682	in 2"	34.39	34	Normal........	
21		1/2"	....	45,848	in 2"	43.75	34	Normal........	
	Means........	....	....	45,033	....	36.46	34		
22	May 17, 1899.	1/2"	20,376	46,255	in 2"	25	23.4		
23		1/2"	16,811	41,773	in 2"	21.9	23.4		
24		1/2"	16,811	42,893	in 2"	21.9	23.4		
	Means........	....	17,999	43,640	....	22.9	23.4		
	Mean of means, 4 to 24, both inclusive........		17,999	47,204	....	26.02	27.42		

pumps under a pressure of about 10 lb. to the sq. in., the pressure being regulated by means of spring relief valves on the pumps. These pumps were tested at intervals to avoid putting an excessive pressure on the planking from the inside. Two sizes of pumps were used for injecting the mixture, the larger size holding was confined to a series of longitudinal sections in the following manner: Each third strake of planking, commencing with the top of the garboard strake, was lightly chinked with a thread of oakum before the next strake was put in place.

The planking began with the keel and garboard

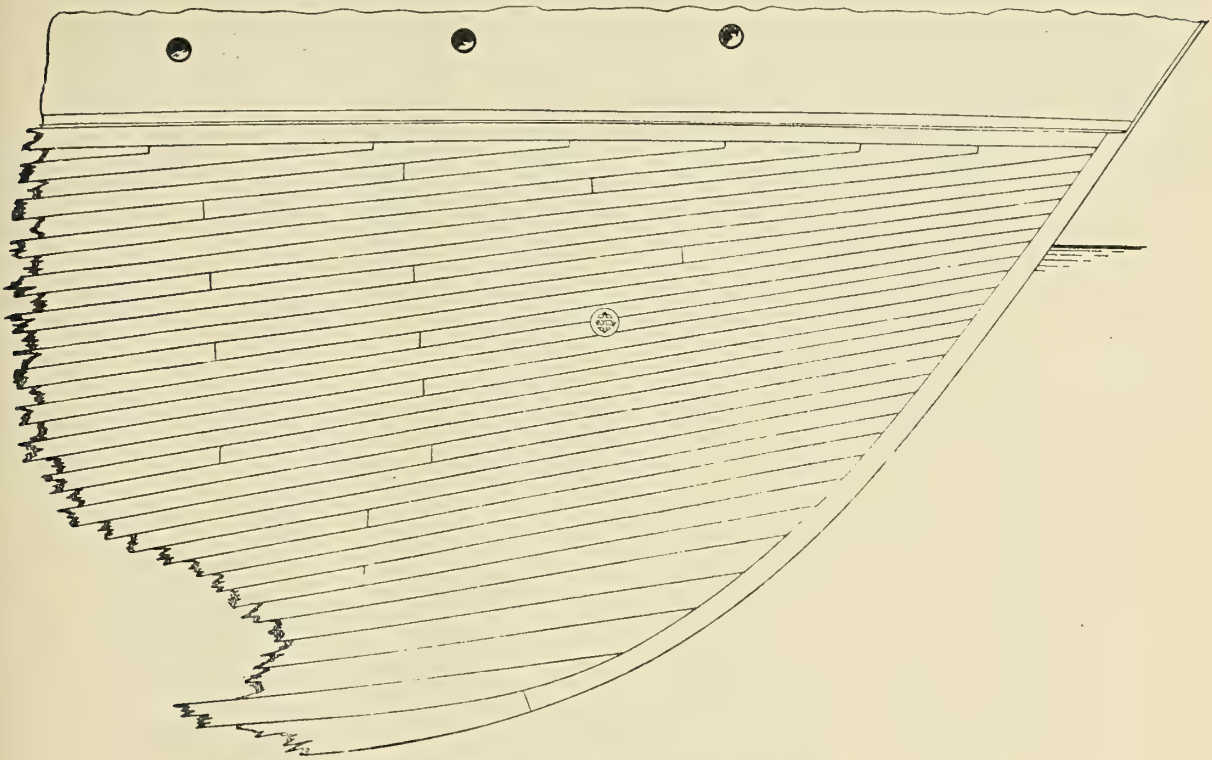


FIG. 3.—VIEW OF PLANKING AT FORWARD END.

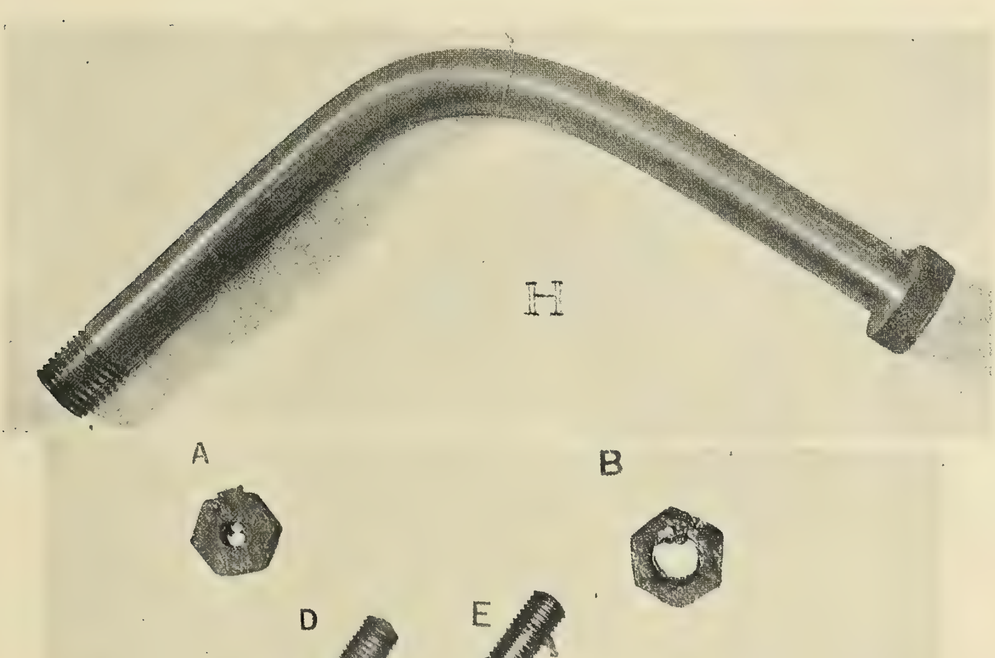


FIG. 2.—PHYSICAL TESTS OF BOLTS USED IN SHEATHING.

strakes, and was worked upwards until completed, the top strake, however, being fitted in place after the garboards. Fig. 3 shows a view of the planking forward.

The following practical points were noted during the sheathing of the *Chesapeake*. Difficulty in making a good water-tight job between the bronze stem and stern-post casting and the outside plating by caulking. The riveting of this work should be arranged in such a manner that it should be tight without depending on the caulking of the outside seams.

TABLE II—HYDE MANGANESE BRONZE CASTINGS FOR U. S. S. CHESAPEAKE.

No.	Date.	Diam. of test piece.	Ultimate tensile strength per sq. in.	Elastic limit per sq. in.	Reduction of area.	Elongation.		Fracture.	Remarks.
25	Apl. 12, 1899.	1"	60,103	....	28%	in 2"	25%	Slight flaw in center	From rudder frame casting.
26		1"	60,281	....	34	in 2"	34	Perfect........	Slow feed used in testing.
27		1"	58,409	....	23	in 2"	28	Slight flaw in center	
	Means......	....	59,598	....	28.3	....	29		
28	Apl 26, 1899.	1"	59,728	....	34	in 2"	34	Perfect........	From stem casting.
29		1"	57,213	28,007	34	in 2"	34	Perfect........	Slow feed used in testing.
	Means......	....	58,470	28,007	34	....	34		
30	Apl. 26, 1899.	1"	61,153	29,287	34	in 2"	34	Perfect........	Stern post casting.
31		1"	60,795	26,738	23.4	in 2"	23.4	Perfect........	Slow feed used in testing.
	Means......	....	60,974	28,012	28.7	....	28.7		
32	June 10, 1899.	1"	54,908	21,645	34	in 2"	34	Perfect........	Extension of stern post.
33		1"	53,689	21,034	34	in 2"	34	Perfect........	Slow feed used in testing.
	Means....	....	54,298	21,339	34	....	34		

It is thought that the greatest trouble may be looked for around the stern-post, and it will be well to examine this part of all sheathed vessels as often as good judgment prompts until more experience is had with sheathed vessels, although the injection of putty under pressure should complete the work of making the sheathing perfectly water-tight.

It was found in several cases that the bolts fetched up against the vertical longitudinal bulkheads in inaccessible places before the heads were up against the planking. These few bolts leaked; but the trouble can be easily remedied by backing out the bolts (which have no nuts on them), shortening them, and heaving them up hard against the planking from the outside when in dry-dock.

In designing a vessel to be sheathed great care should be taken to make the lines around the stern as easy as possible to allow the planking to be bent with as little work as possible, otherwise the planking is strained or else it has to be shaped from large pieces at considerable expense. Oak was substituted in one or two cases under the stern of the *Chesapeake*, as it can be bent more easily when steamed than yellow pine, which is not affected to a marked degree by steaming.

The stern-post, rudder-frame, and stem, up to about four feet above the water-line, were made of Hyde bronze. Table II gives the results of tests of this material taken from the different castings.

WEIGHTS OF MATERIALS USED FOR SHEATHING THE CHESAPEAKE.

152 naval brass 1 3-8 in. keel bolts, b ass nuts and iron washers		1,836 lb.
972 naval brass 7-8 in. plank bolts, brass nuts and iron washers........		1,895
8,103 naval brass 3-4 in. plank bolts, brass nuts and iron washers........		7,874
12 naval brass 3-4 in. plank bolts........		17
5 copper bolts, blunt, 1 1-4 in........		38
37 copper bolts, blunt, 7-8 in........		170
113 composition spikes, 1-2 in. square, 7 in. long........		53
		11,883
Outside planking, yellow pine........	123,403 lb.	
Teak keel........	21,107	
False keel........	2,854	
Oakum and pitch........	6,391	
Putty pumped between plating and planking..	6,857	
Hemp grommets for brass bolts........	65	
Putty for grommets........	500	
Sand and cement for plugging bolt holes........	1,136	
		162,313
		174,196 lb.

RECAPITULATION.

Metal fastening........	11,883 lb.	6.82 per cent.
Yellow pine plank........	123,403	70.84
Teak keel........	21,107	12.13
False keel........	2,854	1.63
Oakum and pitch........	6,391	3.67
Putty and grommets for bolts........	7,422	4.26
Cement for plugging bolt holes........	1,136	.65
77.77 tons =	174,196 lb.	100.00 per cent

Approximate area of sheathed surface (omitting area of flat keel), 7,583 sq. ft.

Weight of sheathing materials per sq. ft. (omitting teak keel, oak false keel, also fastenings of keel and false keel), 23 lb.

The weight of the boundary angle at top of wood sheathing is not included in any of these tables or calculations. This angle is 3 in. by 3 in. by 7 lb. and weighs 2,345 lb.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATÉRIEL.—II.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

The most notable of his experiments was the series which gave the complete demonstration of the relation between cylinder condensation and the rate of expansion. Until these experiments, most engineers believed that the law of Mariotte, that the product of pressure and volume is constant, was strictly applicable to steam as well as to permanent gases, and that a very large ratio of expansion with low pressures of steam would be profitable. Isherwood's experiments on the *Michigan* demonstrated conclusively that under the conditions there obtaining, of a slow-moving engine and a low steam pressure, a ratio of expansion was soon reached beyond which any increase would cause an absolute diminution of economy, instead of an increase thereof, as would have been predicted from a strict adherence to Mariotte's law. Every young engineer knows this thoroughly to-day, and is cautioned about it in his text-books; but so far from its being readily accepted when Isherwood's experiments had demonstrated the true facts, many will remember that he was assailed in the public prints as being guilty either of hopeless ignorance or wilful waste of the Government money.

Mr. Isherwood was not only a splendid experimentalist, but a designer of the first rank, and an executive engineer who has not been surpassed. He was Engineer-in-Chief of the Navy during the whole of the War of the Rebellion, and during that time was responsible for a large number of designs. Here again he was criticised from the academic point of view, and yet the very faults for which he is criticised only appear, on proper analysis, the more praiseworthy as excellent details of sound designing. He was accused of building engines which were inordinately heavy, which accusation he has never denied. To the mere office engineer this was true, but he realized what they did not, that these engines had to go into the hands of men who were largely untrained and unfamiliar with machinery. The ordinary formulæ for design assume reasonably decent handling, and do not provide for the stresses due to ignorance and carelessness. Isherwood knew that the point of first importance was to build engines which would not break down, and, in fact, could not be injured by ignorant and careless handling. The result of this policy was engines very much heavier than would ordinarily be built; but they did not break down, and they carried our ships to victory. To my mind this was the highest proof of his talent as a sound designer. He had the courage to invite criticism from the book engineer in order that he might insure success for the country.

You all know the story of the *Alabama*, and how she and her sister commerce destroyers drove our merchant marine off the ocean. The Navy Department felt it important to get a class of vessels that would be faster than the *Alabama*, or any other vessel likely to be built, so that they could sweep the seas of all these commerce destroyers. A number of designers were concerned in projecting both hulls and engines to accomplish this result, but although the great Ericsson was one of his rivals, Isherwood's ships were the only ones which really accomplished what was intended. The *Wampanoag* was the first of Isherwood's ships to be tried, and she was a magnificent success in every way—really in many ways the greatest success as a steam war vessel that the world has ever known, because she distanced everything that had preceded her so much more than has ever been accomplished before or since. The *Wampanoag* was given a trial lasting 37 1-2 consecutive hours between Sandy Hook and Cape Hatteras, and for the whole run averaged nearly 17 knots per hour. During several 6-hour periods her speed was over 17 knots, and for several single hours she made over 17 1-2. It should be noted also that this was not a smooth weather run, as the trial was ended prematurely owing to a gale, and for some time previous the weather was heavy. The speed made by the *Wampanoag* was at least 4 knots more than that of any other ship—either mercantile or naval—of her period, and, in fact, it remained the record speed for many years. Even the first fast cruisers of modern navies, like the *Esmeralda* and *Naniwa*, while nominally credited with a higher speed, only made it over the measured mile, or for a short spurt, while the *Wampanoag's* record was, as stated, for more than 37 hours. Another of the Isherwood ships, the *Ammomoosic*, was given only a short trial, but showed qualities equal to those of the *Wampanoag*. The best of the rival ships made a speed of about 15 knots for less than an hour, and the other vessels fell below the *Wampanoag* even more than this.

It is not perhaps generally known that in calling the *Wampanoag* an "Isherwood" ship the designation is more inclusive than might be supposed at first glance, for Mr. Isherwood was responsible for those features of the hull design which affect speed. The design of the hull as a whole was worked out by Naval Constructor Delano, an accomplished naval architect, but he simply took the form of hull by Mr. Isherwood and worked out the structural details necessary to carry out his ideas.

It would be supposed that Isherwood's brilliant achievements would have brought him only gratitude and thanks; but, on the contrary, his vigorous methods had aroused a great many enemies, so that at the end of his second term as Chief of the Bureau of Steam Engineering there was sufficient influence to prevent his reappointment to the office which he had so well filled, and he was banished to the Mare Island Navy Yard; but this only gave him an opportunity for some of his best experimental work, and the famous propeller experiments, which are still a mine of valuable information for designers, were conducted there with the assistance of William R. Eckart, a former engineer of the navy and an honored member of this society.

After these experiments, and until his retirement, Mr. Isherwood conducted many others which have given valuable information to engineers, and it may be well in passing to remark that his reports of experiments are models to which all young engineers can refer with great profit to themselves. The thoroughness with which the apparatus under experiment is described and its dimensions given, the elegance and lucidity of the language, and the admirable arrangement, are all models of what such a report should be, just as Macaulay's style is so justly commended to all young writers.

From a remark which has just been made as to the

*President's address (1899) at New York meeting of American Society of Mechanical Engineers.

qualifications of many of the engineers who came into the navy during the War of the Rebellion, it might perhaps be inferred that there were few men of real ability; but this would be unwarranted, and would be an entire mistake. The total number of engineers was so large that it was utterly impossible to have even a majority of them skilled men; but a number of talented young engineers came into the service, and the profession generally has learned to recognize their ability from the fact that in the years since the close of the war a large proportion of the leaders in mechanical engineering in our country are men who were naval engineers during the war. The first president of this society (Dr. Thurston), as well as the second (Dr. Leavitt), were naval engineers, and so was that other able man, Charles E. Emery, now gone to his long rest. William Everett, who became famous in connection with the laying of the first Atlantic cable, was another, and so was George Westinghouse, whose wonderful achievements, both as an inventor and as the creator of great industrial works, entitle him to be called the Napoleon of industrial engineering. Theodore Cooper, the great bridge engineer, and Lay, the inventor of the automobile torpedo, were naval engineers during the war. We must also call attention in passing to Chief Engineers Alban C. Stimers and Isaac Newton, who brought the original *Monitor* down to Hampton Roads and enabled her to whip the *Merrimac*. But for their ability and indefatigable labors the results would have been very different. We might also recite case after case of gallantry and daring where vessels were saved by the skill of the engineers; where they lost their lives through attention to duty, or where they distinguished themselves specially in other ways, but time will not permit us to dwell upon these features.

During all the period which we have thus far considered, the engineers for the navy had obtained their education outside of naval influence; but in 1866 a class of young men was ordered to the Navy Academy to be trained as engineers in a naval atmosphere. A number of these gentlemen are still in the service, and were chief engineers of our large vessels during the recent war with Spain. In 1871 engineer cadets were appointed for the Naval Academy, the course being for two years only, until in 1874 a class was appointed whose course was to be for four years.

These young men were appointed by competitive examination open to the whole country, and as the course became better known the numbers who came to compete increased, and their attainments became so high that an unusually able class of young men was obtained as cadet engineers. Unfortunately for the service, Congress was seized with one of its periodical fits of retrenchment, and as no patronage was affected by abolishing the cadet engineer system, the separate course for engineers was wiped out in 1882, and for a time engineering education dropped out of the curriculum at the Naval Academy.

It is probably safe to say that the young men graduated from the Naval Academy under the cadet engineering system presented a higher average ability than any equal number of young men from any of our great technical schools; indeed, so great was their ability that the service was unable to retain them, but the country has profited from the training they received by their work in civil life. A number are filling positions as professors of mechanical engineering in our leading colleges; a number are consulting engineers of the highest rank, and several are engaged in the management of our large manufacturing enterprises—one (who is a vice-president of this society) being the general manager of one of the largest electric companies in the world. It is a peculiar pleasure to me to bear tribute to the talents of these young men, because a great many of them have served as my assistants in the Bureau of Steam Engineering, and while I am naturally filled with regret that the navy should lose their services, I also feel proud that my own judgment in estimating their ability should be so thoroughly confirmed by the esteem in which they are held by engineers outside of the navy. I would not have it supposed from my remarks about those who have left the service that they took all the ability with them. Some of the most useful and accomplished officers, graduates and non-graduates, are still in the service, which I trust will be able to retain them.

In this connection, too, it is only right that I should bear testimony to the worth of the men who, at the Naval Academy, trained these young engineers. One of the earliest of the instructors was Dr. Thurston, the first president of this society, whose fame as an educator is world wide; but there were others who, while not so well known, nevertheless did splendid work. Just as I remarked at an earlier point about the work of Mr. Haswell and others as pioneers, so it was with these early instructors in engineering at the Naval Academy, who had practically no text-books, and who were compelled, in the professional part of the instruction, to depend almost entirely on their own experience; further than this, they had nothing to guide them in the way of a curriculum, and they were compelled to establish one tentatively and develop it as experience dictated.

Curiously enough, just about the time when Congress was undoing the splendid engineering work at the Naval Academy, the Navy Department itself was formulating plans for vessels which should be designed along lines so different from those which had preceded that the familiar epithet applied to them—the "new navy"—is entirely appropriate. The labors of the first advisory board made available a mass of information, as a result of which Congress in 1883 authorized the building of the four Roach cruisers, which were the beginning of the new navy. These vessels, I may say in passing, although possessing few features of novelty, as far as marine engineering in general is concerned, were nevertheless a marked change from the old wooden ships which had preceded them, and they rendered very valuable service, and are still, with modernized machinery, very satisfactory and useful vessels.

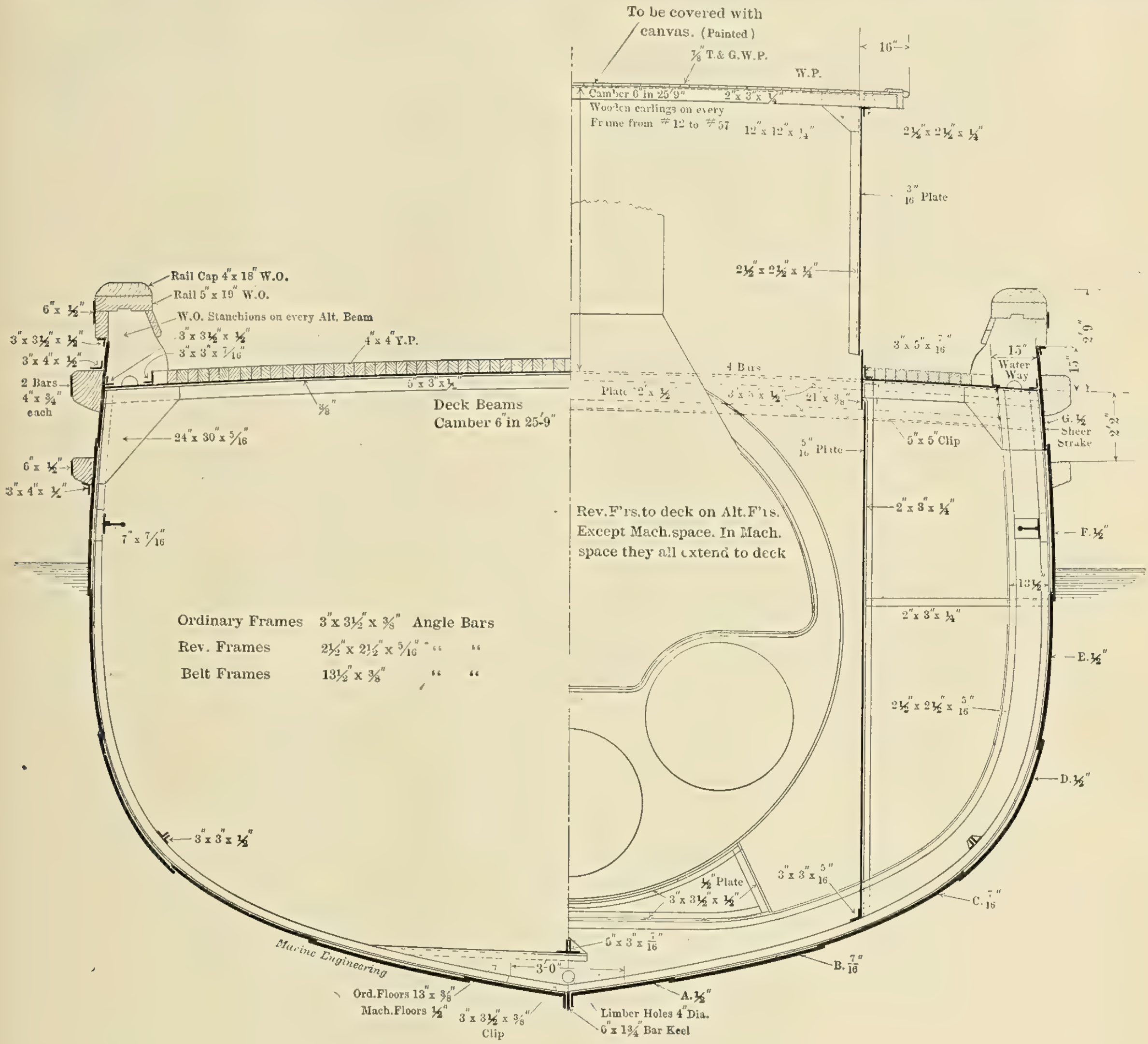
Through an unintentional error in connection with the publication of an extensive description of the new United States floating steel dock for Algiers, La., in our February issue, we omitted to acknowledge our indebtedness to Joseph Beale, Washington, D. C., for most of the data presented and the accompanying drawings. Mr. Beale is the representative in this country of Clark & Stanfield, the leading firm of designers of floating docks of London, England.

NEW STEEL SCREW TRANSFER TUGS FOR THE N. Y., N. H. & H. RAILROAD CO.

Two large, powerful steel screw tow boats for the New York, New Haven and Hartford Railroad Co., to be used as transfer tugs between Oak Point and Jersey City in New York harbor, are now under construction at the yard of the Bath Iron Works, Bath, Me. These vessels are very interesting examples of their type. They are ideal tow boats for inland or harbor work, and their hulls are as small as it is possible to make them and envelop the powerful machinery required.

The principal features of these vessels are: Very large boiler power in relation to the size of engine; airy accommodation for the crew all above deck; large roomy engine and boiler rooms; heavy oak rail for towing purposes throughout the length of the vessel; large water tanks, well arranged for trimming fore and aft and for listing athwartships; first-class arrangements for rapidly handling the vessel and her car floats.

In dimensions these tow boats are as follows: Length over all, 134 ft. 6 in.; load water line, 119 ft. 6 in.; beam, 25 ft. 9 in.; depth, at side, 16 ft. 3 in.; at center, 16 ft. 9 in.; draft, forward, 11 ft.; amidships, 11 ft. 9 in.; aft, 12 ft. 6 in. They have a solid bar keel 6 in. deep and 1 3-4 in. thick, the scarphs being 17 1-2 in. long, well planed and calked. The stem is a wrought iron bar 8 in. deep and 2 in. thick, well rabbeted to receive the shell plating, and scarphed to the keel. The stern frame proper is also an iron bar 6 in. deep and 3 in. thick. It is rabbeted to the keel, bossed for stern tube, and in the tuck it is twisted and forged so that the stern frame, which continues to the extreme aft end of the fantail on counter, is a bar 6 in. wide, varying in thickness from 3 in. to 1 in. The shoe is a very heavy forging welded to the main stern post. It is about 12 in. wide and 5 to 6 in. thick. A balanced rudder of unusual proportions is fitted with a face 9 ft. 6 in. long, of which 2 ft. 6 in. is balanced. The frame is of wrought iron, forged in one piece. The stock is 8 in. dia., and the pintle is 6 in. dia. There are two arms or braces, the space between them being filled in with pine; the whole being covered with steel plating well riveted and tapped to the stock and frame.



CROSS SECTION OF STEEL TUGS FOR N. Y., N. H. & H. RAILROAD CO.

The frames are of angle steel, 3 1-2 in. by 3 in., spaced 23 in. apart throughout the vessel's length. Double or intermediate frames are worked for seven frame spaces forward and four frame spaces aft, in the vicinity of the load water line, to resist crushing by ice. There are belt frames in the vessel located where the deck is cut at the hatches, and where the greatest weights are placed and the greatest stresses are apt to occur. Reverse frames of angle steel, 2 1-2 lb. by 2 1-2 in., are located on every frame, extending to 1 ft. above the bilge and to the deck stringer on alternate frames. Double reverse frames are worked in the machinery spaces. The floors are in one piece on every frame, 13 in. deep at the center line amidship. The main deck beams are 5 in. by 3 in. extra heavy angle bars located on every frame. The shell plating is composed of a heavy flanged garboard strake, a heavy sheer strake projecting 15 in. above the main deck at the side, and four strakes of 1-2 in. bottom, bilge and side plating arranged as usual in "in and out" strakes. The gutter waterway on deck is 15 in. wide, and it is bounded by 3 1-2 in. by 3 in. angle bars. The main deck stringers and deck plating are 3-8 in. thick. The bilge keelson is composed of double angles riveted back to back. The side stringer is a 7 in. extra heavy bulb tee bar, and both bilge and side keelsons are continuous from stem to stern.

The tugs have each six complete watertight transverse bulkheads, composed of 1-4 in. steel plate, well stiffened by angle bars the same size as the frames. Bulkhead No. 5 is the collision bulkhead and the forward bulkhead of the forward tank. Bulkhead No. 12 is the after bulkhead of the forward tank and the forward bulkhead of the steering engine space. Bulkhead No. 18 is the forward bulkhead of the boiler room and wing bunkers and the after bulkhead of the steering engine space. The space between frames 12 and 18 will be used for hawser stowage, lamp room, steering engine and miscellaneous deck gear stowage. A steel flat at the level of the lower deck divides this space vertically. Bulkhead No. 39 is the after boiler room and wing coal bunker bulkhead and the forward engine room bulkhead. Bulkhead No. 55 is the after engine room bulkhead, the stuffing box after peak bulkhead, and the forward bulkhead of the after tank. Bulkhead No. 61 is the after bulkhead of the after tank. The steering gear occupies the space aft of bulkhead No. 61 in the lazarette. The two large tanks extend from the floors up to the main deck. They are divided in the center line of the ship by a steel bulkhead well stiffened, the only communication between the two sides of the ship being through an area of about 1 sq. ft. near the base.

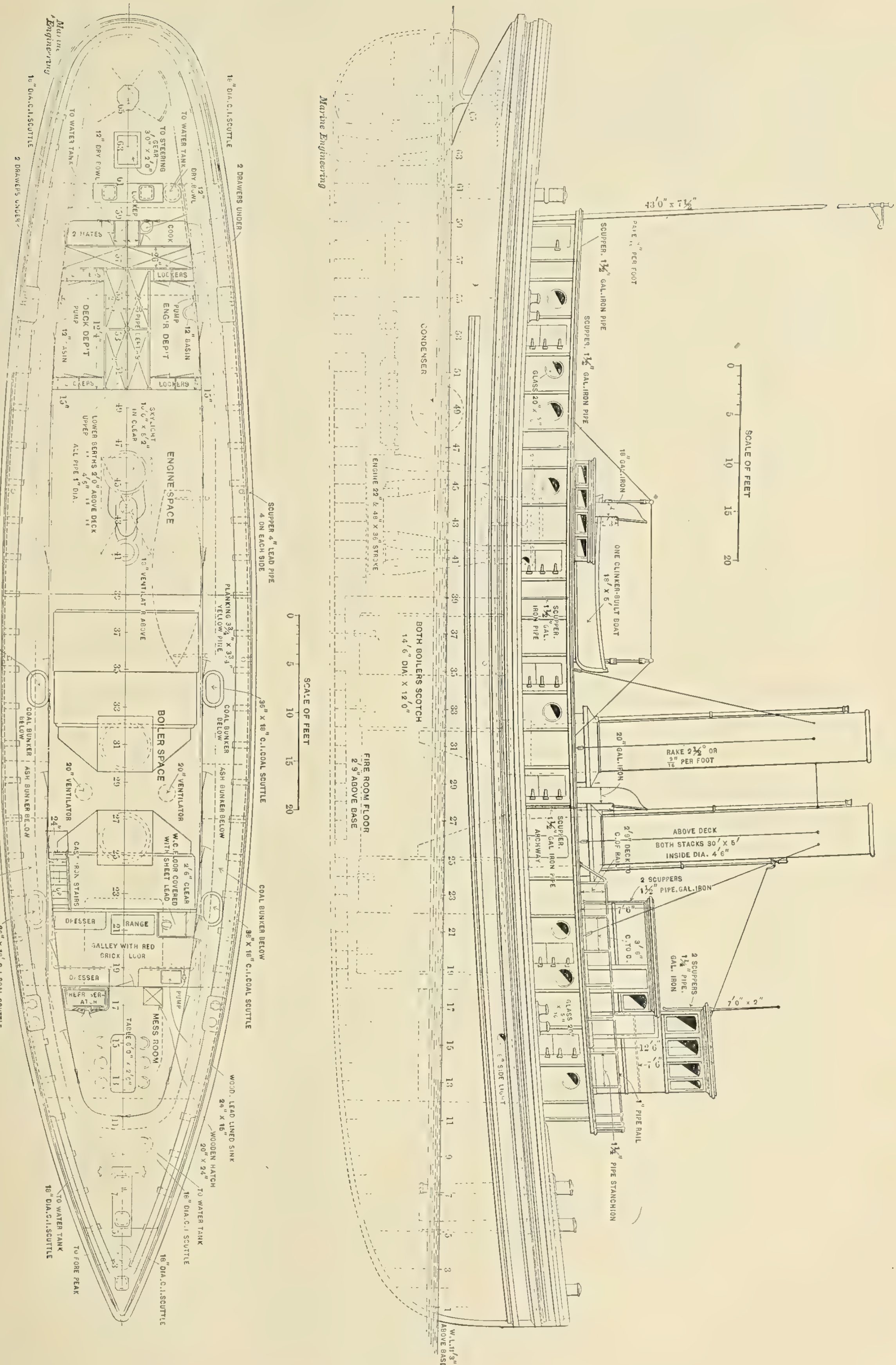
There are no athwartship coal bunkers on these vessels, and the wing bunkers extend from frames 18 to 27, and from frames 30 to 39 on each side. Ash bunkers, or space for stowage of ashes, are located in the wings, midway between the bunkers on each side of the vessel. The floors under the engines are increased in depth, and four continuous fore and aft keelsons are fitted. The two inboard keelsons extend aft under the thrust bed, and the holding down bolts for the engine and thrust bed pass through the reverse angle on top of these intercostal keelsons. The engine and thrust-bed framing is plated over with heavy steel plate, the engine bed being perfectly flat. The shaft tube of each tug is a steel plate tube strapped on the outside and riveted to a boss on the stern frame and to the after peak bulkhead, and two ordinary frames by means of angle bar collars.

The steel deck house is 92 ft. long, and at its widest part 15 ft. 9 in. wide. It is constructed with a vertical steel coaming plate, secured to the steel deck by a 5 in. by 3 in. angle bar. The side plates run vertically and being butted at their edges, the strap placed on the outside, have a panelling effect. These plates are 3-16 in. thick and about 4 ft. wide. The deck house stiffeners are 3 in. by 2 in. angle bars, and the beams are of the same size, a wooden carling being fastened to each one of them. The fore and aft coal bunker bulkheads are composed of 5-16 in. steel plates and amidships this bulkhead is directly connected to the coaming plates of the deck house.

The main deck is planked with 4 in. by 4 in. yellow pine. The top of the deck house is made of 7-8 in. tongued and grooved stock, and this top overhangs the steel house 16 inches. One of the features of the ship is the heavy and well connected oak rail. The stanchions for the rail are of white oak, located on every other deck beam. They are 21 in. by 7 in. at base and 24 in. high. The rail is white oak, 19 in. by 5 in., and the rail cap is of the same material, 18 in. by 4 in. The rail is well secured to 4 in. by 9 in. outside plank and angle bar on top of the shear strake. It is also well secured to the deck stringer, and each stanchion is fastened to the rail and rail cap, being let into the former about 2 inches. A 3 in. by 9 in. oak plank is also secured to the rail and rail stanchions on the inboard side.

Four extra heavy cast iron bitts are located on the top of the rail, one on each quarter. The inboard forward bitts are of white oak, standing fore and aft, and stepped on a platform below the level of the lower deck in the forward tank. The bitts are 16 in. square capped with a brass cap 1 in. thick. A Hyde hand windlass with double gypsy head is directly connected to these bitts. The after bitts are the same as the forward ones except that they stand athwartship just abaft the aft end of the house. They step in the after tank at a height just above the lower deck. A nigger head 24 in. high and 16 in. square of oak is located forward, and capped with a brass cap, just abaft the stem head. Chocks are fitted fore and aft above the rail cap. An upper guard or wearing piece is worked all around the vessel at the height of the main deck. It is 13 in. by 10 in. white oak, faced with two 4 in. by 3-4 in. steel plates. A lower wearing piece is worked from the after quarter to the stem on both sides of the ship. It is 9 in. deep and the width varies so that its face, which is capped with a 6 in. by 1-2 in. plate is in the same vertical line with the upper guard face throughout.

The forward compartment of the deck house is the mess room, which contains a table and six or eight chairs. In it is a large refrigerator and a hatch to the steering engine and hawser space below. Then comes the galley, 14 ft. 6 in. by 7 ft. 6 in., with range, dresser, sinks and the usual fittings and furnishings found in a modern, well arranged kitchen. A water-closet is on the port side. The boiler and engine casings occupy



PLANS OF STEEL TUGS FOR N. Y., N. H. & H. RAILROAD CO., BUILT AND ENGINED BY THE BATH IRON WORKS, BATH, ME.

over 53 ft. in length in the deck house. Aft of the after engine casing bulkhead is a space 12 ft. 6 in. long divided at the centre line by a bulkhead. On the port side are four pipe berths for the oilers and firemen, and on the starboard side are four similar berths for the crew of the boat. These rooms are exactly alike and include four lockers and a wash stand with pump directly connected to water tanks below. Aft of these rooms are two staterooms for cooks and mates, complete and well arranged.

The pilot house on the top of the deck house forward is a lofty structure 12 ft. 6 in. high and 8 ft. wide. It will be neatly finished on the inside with black walnut, hardwood floor, lockers, upholstery, etc. The steering wheel connects by vertical shaft with the valve of the Williamson steering engine down below. There is no hand steering gear on the vessel. Aft of the chart house are two staterooms, each containing two berths and lockers. The forward one is for the Captain and the after one for the Engineer. Full-size windows in the aft end of the chart house are located looking over the adjoining house, which is 5 ft. lower than the chart house. The eye of an observer in the pilot house will be over 26 ft. above the water line when the tugs are in the load condition and trimming evenly. The iron deck house is fitted with double swing steel doors throughout and 20 in. circular air ports. A handrail is worked around the forward part of the top of the deck house. A turret skylight is located over the engine casing, and the deck house top is so arranged that the engines and boilers can be easily taken out of the vessels.

One 18 ft. square stern clinker-built life-boat will be carried by each boat on davits. One 800 lb. stockless anchor and 75 fathoms of 1 in. stud link chain will be carried. These transfer tugs have no spars or sails, as they are designed for inshore work. Each vessel will be fitted with a 43 ft. signal staff located at the after end of the deck house. Small flag poles are located at the after end of the pilot house of one to distinguish it from the other.

The rudders of these vessels, as before mentioned, are unusually large, and the steering gear is unusually powerful. A yoke is attached to the rudder head with double quadrants, thus eliminating slack and doing away with the usual quarter guide sheaves. The rudder area is about 110 sq. ft., and this is made so large because it is not only the rudder of the tug boat, but it must act as the rudder of the float which she will tow on either side of her.

These new tow boats will be well lighted by electricity. There will be 50 16 C. P. incandescent lamps, and the generating set will be a 3 K. W. Riker machine with Case engine. They will be well ventilated, and the drainage and piping of the hull will be first-class and complete.

The machinery of these vessels includes a vertical direct acting surface condensing compound engine, driving a single screw. The cylinders are of the following dimensions: H. P., 22 in. dia.; L. P., 48 in. dia., and stroke, 36 in. At a piston speed of 780 ft. per min., 130 revolutions, the engines are designed to indicate about 1,250 I. H. P. The condenser is separate from the engine frame. It is about 5 ft. in dia. and is located just abaft the main engine and over the thrust bearing. It has a cooling surface of 2,500 sq. ft., the tubes being of brass, 3-4 in. dia., tinned both inside and out. There are two single ended Scotch boilers in each vessel built for a working pressure of 140 lbs. The mean dia. of these boilers is 14 ft. 6 in. They are 12 ft. long, and each contains 3 corrugated Morison suspension furnaces 48 in. inside dia. The total heating surface of the two boilers is 4,600 sq. ft., and the total grate area is 168 sq. ft. The ratio H. S. to G.S. is 27.4, and the ratio G.S. to Calorimeter area is 7.2.

It will be seen by these figures that the boiler power is unusually large. The boilers under natural draft will be capable of supplying steam for about 1,700 I.H.P. The average American vessel is under powered in the boiler room, but this will certainly not be the case with the tugs here described, for if one boiler or one-half the steam generating plant is placed out of service on account of some mishap, the other boiler, by using the ventilating blower, will be capable of furnishing all the steam the engine could take care of under ordinary working conditions. Each boiler has its own stack, and above the deck house they are 30 ft. high and 5 ft. outside diameter.

The new tugs will have an excellent equipment throughout, for the owners have given the builders a free hand and they will deliver the vessels complete in every respect and ready for service.

AMENDMENTS TO THE U. S. STEAMBOAT RULES AND REGULATIONS FOR 1900.

At the regular meeting of the Board of Supervising Inspectors of Steamboats, held in Washington, D. C., last month under the direction of Supervising Inspector General James A. Dumont, amendments to the existing steamboat rules and regulations were adopted. Following is the text of the rules amended in part only, the parts struck out enclosed in brackets [thus], while the additions to such paragraphs are printed in *italics*. Entirely new sections and paragraphs of sections are in plain type, preceded by the word (new) in parenthesis:

RULES.

Rule I.

SECTION 1. (Proviso added to section, new.)

Provided, however, That where butt straps are used, the stamps in corners shall be extended to a distance not to exceed 8 inches from the edges.

SECTION 4. (First paragraph.)

4. The manufacturer of any boiler to be used for marine purposes shall furnish the inspectors of the district where such boiler or boilers are to be [constructed] *inspected* a blue print or tracing descriptive of same for their approval, which shall be kept on file in their office. * * *

SECTION 5. In both terms of affidavit of manufacturer of marine steam boilers, the words "Holes drilled, ———, or punched" were struck out, and the words "Rivet holes in the shells, heads and flanges of same, steam and mud drums, and holes for stay bolts, drilled and no part punched ————" inserted in lieu thereof.

Rule II.

SECTION 2. (First paragraph.)

* * * The pressures allowable on single-riveted boilers will be found in the first divisions of the double columns (of table) under the tensile strength and opposite the diameters and thickness; and in the second divisions the pressures allowable on boilers where all the rivet holes have been fairly drilled [instead of] *and no part of such holes has been* punched and the longitudinal laps of their cylindrical parts double riveted.

SECTION 2. (Second paragraph.)

All boilers built for marine purposes shall be required to have the rivet holes in the [shell, heads, steam and mud drums, and all other parts of the boiler (excepting for longitudinal and circumferential seams in flues for same 20 inches outside diameter and under), fairly drilled instead of punched], *shells, heads and flanges of same, steam and mud drums, and holes for stay bolts, fairly drilled, and no part of such holes shall be punched.*

SECTION 9. (Paragraph top page 31, Rules and Regulations, 1899.)

Tubes, water pipes, and steam pipes, made of [steel manufactured by the Bessemer process, may be used in any marine boiler when the material from which such pipes are made does not contain more than .06 per cent of phosphorus and .04 per cent of sulphur, to be determined by analysis by the manufacturers, verified by them, and copy furnished the user for each order tested; which analysis shall, if deemed expedient by the Supervising Inspector-General, be verified by an outside test at the expense of the manufacturer of the tubes or pipes]. *Bessemer, acid, or basic open hearth steel shall be required to show the following physical tests, namely, elastic limit per square inch* 30,000 *to* 35,000 *pounds, tensile strength* 50,000 *to* 60,000 *pounds, elongation in* 8-*inch specimen* 20 *to* 25 *per cent, reduction of area* 45 *to* 50 *per cent.*

The manufacturer of boiler tubes shall be required to furnish copies of reports of physical tests of every order for tubes to be used in marine boilers to the boiler maker using the same, and a similar copy to the Supervising Inspector-General, to be filed in his office. No tube increased in thickness by welding one tube inside of another shall be allowed for use.

SECTION 17. (New paragraph, after the fifth paragraph or example.)

To find the radius of sphere of which the bumped head forms a part, square the radius of the head. Divide this by the height of bump required. To this result add height of pump. This will give diameter of sphere, one-half of which will be the radius required.

SECTION 38. (Sixth paragraph.)

The flanges of all copper steam pipes over 3 inches in diameter shall be made of bronze or brass composition, *shall be securely brazed to pipe*, and shall have a thickness of material of not less than four times the thickness of material in the pipes plus .25 of an inch; and all such flanges shall have a boss of sufficient thickness of material projecting from the back of the flange a distance [of not less than three times the thickness of material in the pipe] *sufficient to be properly riveted to the pipe and of a thickness of not less than one-half inch;* * * *

SECTION 38. (New, added to 13th paragraph.)

No connection between shell of boiler and mud drum exceeding 6 inches in diameter will be allowed.

SECTION 40. (Amended.)

40. No cast-iron nozzles, branch pipes, or elbows shall be used in connecting steam drums, super-heaters, branch pipes, or steam pipes to boilers, and *in no other part of steam pipes. Flanges welded to wrought-iron, Bessemer, or other steel pipe may be used.* No cast-iron flanges will be allowed to be used on boilers for marine purposes unless such cast iron has been officially tested and test on record in the office of the local inspectors where boiler with such appliances was constructed, and no cast-iron with a tensile strength of less than 30,000 pounds will be permitted to be used for such purposes. *Semi-steel of not less than* 24,000 *pounds tensile strength may be used for nozzles, stop valves, branch pipes, elbows, slip joints, flanges to boilers, tee pipes, and water and gauge cock pipes or columns, when said semi-steel has been officially tested, and test on record in the office of the local inspectors, same as is required of cast iron.*

Rule III.

SECTION 24. (Amended.)

24. All steam vessels certificated as ocean [lake, bay, or sound] at their annual inspection after the adoption of this rule (except vessels of 100 tons and under, inspected under the provisions of section 4,426, Revised Statutes, and freight and towing steamers, inspected under the provisions of section 4,427, Revised Statutes) shall be provided with a line-carrying projectile and the means of propelling it, such as may have received the formal approval of the Board of Supervising Inspectors.

Rule IV.

SECTION 14. (New, added to Section.)

Each and every steam vessel applying for inspection on and after July 1, 1900, shall be fitted with a bilge pipe connecting by a suitably marked valve with the main bilge pump in the engine room, and each compartment of all steam vessels shall be fitted with a suitable sounding pipe.

Rule V.

SECTION 1. (Last clause of third paragraph.)

[New licenses may also be issued in the case of license lost by wreck, fire, or any other cause, upon a satisfactory showing of such loss to the inspectors, duly sworn to.] *In case of loss of license of any class, from any cause, the inspectors, upon receiving satisfactory evidence of such loss, shall issue a certificate to the owner thereof, which shall have the authority of the lost license for the unexpired term, unless in the meantime the holder thereof shall have the grade of his license raised after due examination; in which case, a license in due form for such grade may be issued.*

SECTION 1. (Last paragraph.)

* * * and no license shall be issued as above except upon the official recommendation of the chief officer in command of the naval *militia* station of the State in which the applicant is serving.

SECTION 9.

9. Masters and pilots of [passenger] steamers *carrying passengers for hire* shall exclude from the pilot

houses of such steamers, while under way, all persons not connected with the navigation of such steamers, except officers of the Steamboat Inspection Service, licensed officers of steamboats, persons regularly engaged in learning the profession of pilot, officers of the United States Coast Survey, Lighthouse Service, and engineer officers connected with the improvement of rivers and harbors. [The supervising inspectors, however, shall have the power, if in their judgment it will not endanger life on board of such passenger steamers, to grant permits authorizing the masters of such steamers, except when such steamers are making excursions under permits granted by the inspectors, to allow a limited number of such persons as they may deem proper in the pilot house of such steamers between the hours of sunrise and sunset, on the condition that such persons will not in any way interfere with the pilots in the performance of their duties. In the case of any violation of the conditions of any such permit it shall, upon demand, be surrendered to the supervising inspector having jurisdiction, and no such permit shall again be issued to any such master by any supervising inspector except the supervising inspector of the district to whom it was surrendered, and not by him until it shall be shown to his satisfaction that all the provisions of such permit will thereafter be complied with.]

The master of every passenger steamer shall keep three printed copies of this section of Rule V posted in conspicuous places on such steamer, one of which shall be kept posted in the pilot house.

Such printed copies shall be furnished by the Treasury Department to local inspectors for distribution among the passenger steamers of their respective districts.

SECTION 10. (Last paragraph struck out.)

[In case the applicant shall be found incompletely color-blind the local inspectors shall examine with the colored signal lights, and if satisfied that the applicant can sufficiently distinguish the color signals used on steam vessels they may, in their discretion, renew the license of such applicant.]

SECTION 12. No original license for pilot of any route shall be issued to any person, except for special license on small pleasure steamers and ferryboats navigating outside of ports of entry and delivery, who has not been employed in the deck department of a steamer [or], sail vessel, *or barge consorts* for the term of at least three years preceding the application for license. * * *

SECTION 14. (Third paragraph.)

[And] No original license as master [or mate of ocean steamers, or of coastwise steamers plying upon waters of the ocean or high seas], *of ocean or coastwise steamers shall be issued to any person who has not had three years' experience on steam or sail vessels preceding the application, one year of such experience to be as chief mate of steam vessels. No original license as chief mate of ocean or coastwise steam vessels shall be issued to any person who has not had three years' experience on steam or sail vessels, and must have served one year as second mate of steam vessels, such service to be immediately preceding the application. No original license shall be issued to second mate of ocean or coastwise steam vessels who has not had three years' experience in the deck department of steam or sail vessels immediately preceding the application, one year of such service to be on steam vessels. And no original license as master or mate of ocean or coastwise steamers* shall be issued to any person, or grade of license raised, or route extended, who does not understand navigation, and who is not able to determine a ship's position at sea by observation of the sun, to obtain longitude by chronometer, and to determine ship's latitude by meridian altitude of either the sun, moon, or stars. The examination to determine his qualifications shall be in writing, which shall be kept on file in the office granting such license; and all examinations of other masters, mates, or pilots shall be in writing and kept on file for reference: *Provided, however,* that applicant for original license to act as master or mate of steam pilot boats, or of steamers engaged in the Atlantic, Pacific, or Gulf coast fisheries, *or of steam or sail vessels navigating between the ports of the Hawaiian Islands, or betwen ports of the island of Porto Rico,* shall only be subjected to such examination as shall satisfy the inspectors that the applicant is a competent coast pilot, capable of navigating such steamers.

SECTION 25. (Fourth paragraph.)

25. Starting, stopping, and backing signals for steam vessels navigating the waters of the eighth and ninth supervising inspection district, and so much of Lake Superior as is included in the fifth district.

* * * * * * *

There shall be used between the master or pilot and engineer the following code of signals, to be made by bell or whistle, namely:

1 whistle or *1* bell	Go ahead.
1 whistle or *1* bell	Stop.
2 whistles or *2* bells	Back.
[3 whistles or bells	Check]
[1 long whistle] *4 whistles* or 4 bells	Strong.
[1 long whistle] *4 whistles* or 4 bells	All right.

Two whistles or two bells [when the engine is working ahead will always be a signal to stop and back strong], *shall always mean back, irrespective of other signals previously given.*

Rule VII.

SECTION 1.

1. All double-ended ferryboats on lakes and seaboard shall carry a central range of clear, bright, white lights, showing all around the horizon, placed at equal altitudes forward and aft; also such side lights as specified in [section 4,233 of the Revised Statutes, Rule III, Paragraphs B and C], *paragraphs (b) and (c), Art. 2, Act of Congress approved June 7,* 1897. * * *

Rule IX.

SECTION 1.

1. The inspectors shall visit places where marine boilers are being constructed as often as possible, for the purpose of ascertaining and making a record of the stamps upon the material, its thickness and qualities; *except when material has been tested at the mills by an assistant inspector, when that officer's report of material, together with the boiler-maker's affidavit, may be accepted for the data required.*

SECTION 2. (New paragraph added at end of section.)

Local inspectors inspecting sail vessels carrying passengers on the ocean or on the high seas, of over one hundred gross tons, under the provisions of section 4,417, Revised Statutes, as amended by the act of Congress approved December 21, 1898, shall require such

sail vessels to be equipped with a life-preserver for every person on board, passengers and crew, and with such number of good and substantial life boats according to tonnage, in accordance with the requirements of section 12, Rule III., Rules and Regulations.

SECTION 8. (Third paragraph.)

All steam whistles shall be placed not less than 6 feet above the top of the pilot house of steam vessels where the height of the smokestack will admit the attachment of same below its top, when not hinged for passing under bridges, except upon steamers navigating the Red River of the North and rivers whose waters flow into the Gulf of Mexico, and steamers of less than 100 gross tons, whose steam whistles shall be placed not less than 2 ft. above the tops of their pilot houses; and *all double-ended ferry steamers and steamers similarly constructed shall have a steam whistle both fore and aft of the smoke pipe; or if only one whistle is used, said whistle shall be placed on the side of smoke pipe so that the steam, when whistle is blown, can be seen from either end of steamer;* and it shall be the duty of inspectors to enforce this rule at the annual inspection.

PILOT RULES FOR ATLANTIC AND PACIFIC COAST INLAND WATERS.

RULE II. When steamers are approaching each other in an oblique direction, as shown in the diagrams of the fourth and fifth situations, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other, which latter vessel shall keep her course and speed; the steam vessel having the other on her starboard side indicating by one blast of her whistle her intention to direct her course to starboard, and two blasts [if directing her course to port, to which the other shall promptly respond], *her intention of directing her course to port so as to cross the stern of the steamer, which signals must be promptly answered by the steamer having the right of way,* but the giving and answering signals by a vessel required to keep her course shall not vary the duties and obligations of the respective vessels.

RULE IV. (First paragraph.)

When steamers are running in a fog [or thick weather], mist, falling snow, or heavy rainstorms, except when towing, it shall be the duty of the pilot to cause a long blast of the whistle to be sounded at intervals not exceeding one minute.

RULE IV. (Last paragraph struck out.)

[Steamers, when at anchor in the fairway of other vessels in a fog or thick weather, shall ring their bells at intervals of not more than two minutes.]

A statement prepared by the Paymaster General of the Navy shows that more than half of the emergency fund of $50,000,000, appropriated by Congress for the fiscal year ending June 30, 1898, was expended by the Navy Department. The total foots up $27,356,863. Among the various items which contribute to this total are: Purchase of vessels, $7,431,765; new construction and repairs, $1,112,515; Bureau of Ordnance, $5,582,888; purchase of guns, ammunition and supplies abroad, $1,327,017; hire and expenses of chartered vessels, $475,-422; Bureau of Equipment, $399,937.

DETAILS OF CONSTRUCTION AND OPERATION OF RUSSIAN ICE BREAKER ERMACK.

In the last issue of the Notes on Naval Progress by the United States Office of Naval Intelligence there is an extended reference to the Russian ice breaker *Ermack*, accompanied by plans of the vessel. These we reproduce, together with other interesting information concerning this remarkable vessel which has not been published in previous references to her in these columns.

Fully three times as powerful as any vessel (ice breaker) previously constructed, the *Ermack*, designed by Vice-Admiral Marakoff, of the Russian imperial navy, and built last year in England by W. G. Armstrong, Whitworth & Co., for the Russian Government, deserves particular study, by reason of the novel features in her construction. Her principal dimensions are as follows: Length, 305 feet; beam, 71 feet; depth to upper deck, 42 feet 6 inches. At no point are the lines of her hull straight, thus assisting in disengaging her from fields of ice when there is danger of her being frozen in. This form of hull and the great strength of the structure would result in the ship being lifted bodily rather than giving way in case the ice closed about it. The strength and rigidity of the hull are so great, in fact, that if the ship should be suspended by the bow and stern without any intermediate support no damage could ensue. The heavy web framing and the plating of ice belt extending entirely around the hull, like the armor of a modern warship, with a maximum thickness of 1 1-4 in., render the outer skin impregnable to attacks of ice.

The *Ermack* has her bow designed with a very long overhang, so that the attack on the ice takes the form of a sliding blow, and if the resistance encountered is more than sufficient to overcome the breaking strain thus produced, the momentum of the vessel is expended in lifting the bow on to the top of the ice. Meanwhile the water supporting the ice is violently disturbed by the action of a propeller arranged under the cutaway bow, so that under the effect of the weight of the vessel acting above and enhanced by absence of support below the ice gradually yields. The action thus described will take place continuously when working in thick ice. The foremost part of the bow is composed of a solid steel casting. Three screws are placed at the stern, one being on the center line, as in ordinary single-screw vessels, and the other two as in the usual twin-screw arrangement. The four screws are arranged so that large blocks of ice may be carried clear of the hull or out of the way of the advance of the vessel by means of the current or race due to their working.

It is hardly necessary to say that an ice-breaking steamer, to be effective, must have remarkable manœuvering powers, as vessels working in frozen seas have the very smallest space to turn in at times. For this reason the twin-screw arrangement was desirable; but with twin screws the efficiency of the rudder may be lessened, as the propeller race is not thrown directly upon it, as is the case with one screw directly forward of the rudder. The bow screw is not introduced for speed purposes, but simply to enable the ship to clear her way and keep lumps of ice from accumulating un-

der her bottom. All four propellers are four-bladed, made of nickel steel, and enormously thick, being calculated to be brought up by ice without breaking when running at full speed. The machinery is all designed to withstand this test.

The vessel is divided into forty-eight absolutely water-tight compartments, of which fourteen are in the double bottom. There is one cross bunker for coal, as well as side bunkers. The fore and after peaks are arranged for trimming purposes, so as to bring the vessel by the head or stern with water ballast. There are also two heeling tanks amidships. In case the ice crowds the ship on one side the tank on that side can be filled, and an extra pressure of some hundreds of tons brought to bear on it so as to right the ship and crush the ice down into the water. Both tanks would be filled if it were found that the ice was raising the ship bodily. The weight and shape of the *Ermack* would make her roll considerably in a sea way, and she cannot have bilge keels, since they would afford a grip hold for the ice; therefore, she has also been provided amidships with a third, or anti-rolling, tank. Connected with these tanks are pumps of enormous power, so that if the vessel gets caught in the ice her horizontal plane may be varied in any sense desired, whereby she may the more readily release herself.

The pump room is a well perfectly watertight, let into the middle of the vessel and descending to within seven feet of the bottom. The salvage pump has a capacity of ten tons per minute, and if the ship were flooded above the level of this pump the latter would be still accessible. The ballast pump is arranged so that it can take hot water from the boilers and pump it into the fore peak, the hot water overflowing through valves in the bow and running down the outside of the skin plating. This is designed with the purpose of preventing rough ice from adhering to the hull.

At the stern the vessel is shaped much like a cruiser, but instead of being rounded off has a deep groove, furnished with fenders, intended to receive the stem of another steamer of the ordinary type in conducting her safely through the broken ice. By means of a powerful winch the second steamer may be braced up taut, and thus be enabled to add her power to that of the ice breaker in struggling with the ice.

Another interesting feature is the so-called ice box, an open tube amidships from the main deck down to the water under the ship's bottom. Through this the boilers are fed with water direct from the sea beneath. This tube is connected with a glass pipe set against a wooden scale, on which are marked on one side the number of feet that the vessel is drawing, and on the other the number of tons which the ship displaces at that draft. The total displacement of the *Ermack* is 8,000 tons: indicated horse power of the engines, of which there is a set of the triple expansion type to each propeller, is 12,000, giving a maximum speed, it is understood, of 16 1-4 knots. The results of the steam trials showed that the speed with 8,000 I. H. P. was nearly 15 1-4 knots.

Experience with the *Ermack* has shown that pack ice of practically any thickness can be negotiated. On one occasion she encountered a pack which was measured and found to be of a total thickness of 34 feet, nine feet being above the level of the field, and through which she successfully forced her way, a feat which would have been quite impossible but for the action of the forward propeller.

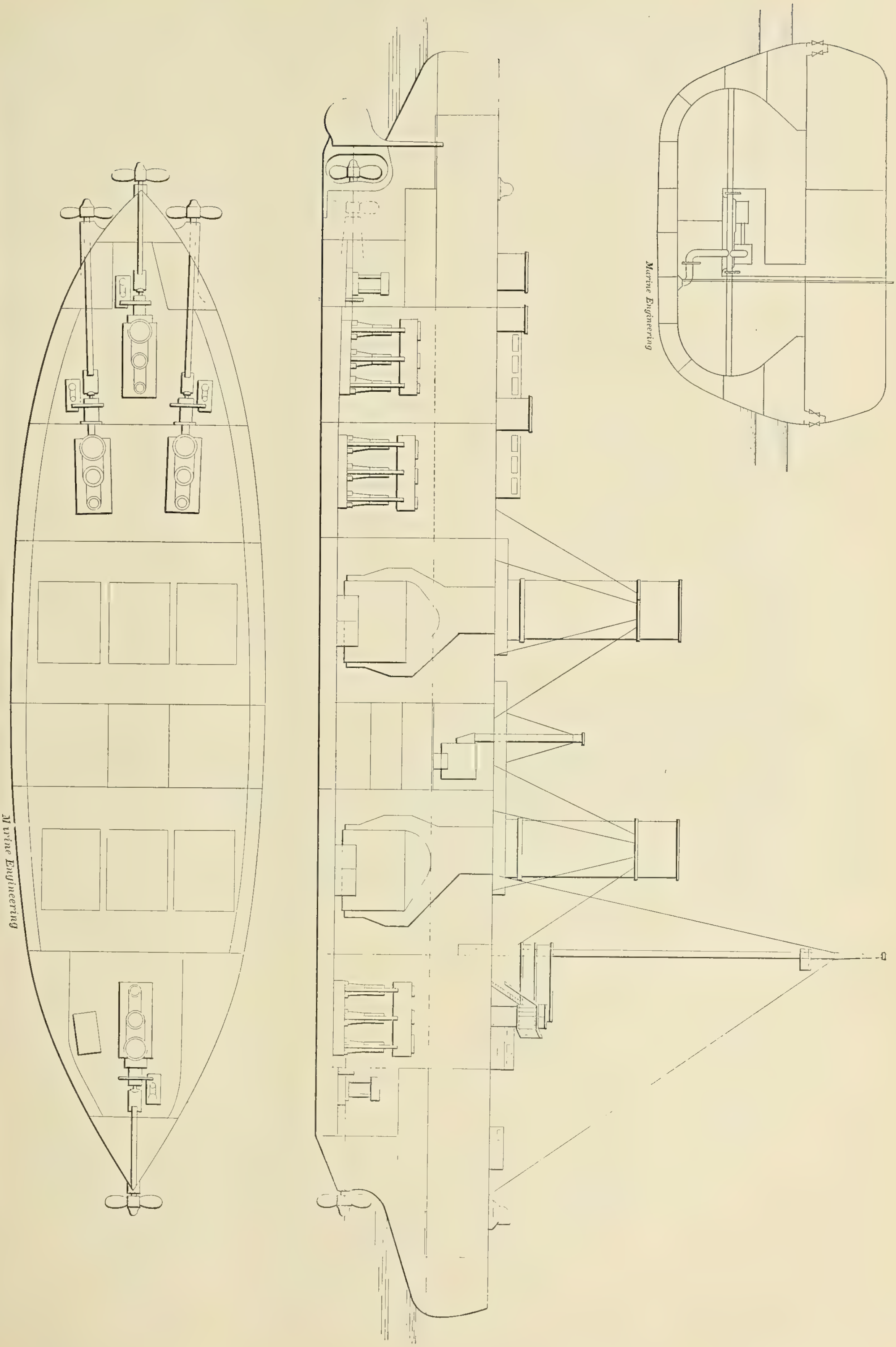
As a factor in naval operations it is not difficult to estimate the possibilities of a vessel like the *Ermack*. It looks as if the Russian fleet can no longer be considered as icebound when wintering in the Baltic ports or Vladivostock—a fact of very considerable importance in the event of Russia finding herself engaged in a naval war. Moreover, the vessel itself would be distinctly formidable as a ship of war. As a ram she would be a deadly weapon of offense if she once got her blow home, especially on a ship with a low freeboard, for she would bear her down by her overwhelming weight until she filled and sank, while the *Ermack* herself would be invulnerable as long as her engines and boilers, which are exceptionally protected, were intact.

According to latest advices (October 19, 1899), the *Ermack* is shortly to take up a more important work than ever. This is to keep navigation open during the winter, not only between St. Petersburg and Cronstadt, a distance of twenty miles, but also as far as Reval and Libau on the Baltic. If the *Ermack* succeeds in keeping the Gulf of Finland and the Baltic open to navigation the shipping trade of St. Petersburg will be greatly affected thereby. Hitherto the shipping trade of the capital and Cronstadt has been impossible for about six months of every year. During the winter a certain amount of trade is carried on by rail to those Baltic ports which happen to be open to navigation.

The trials of the *Ermack* commenced with a four hours' consumption run, with the main propelling engines developing a combined horse power of 8,000, when the consumption of coal was found to be 1.52 lb. per I.H.P. per hour. The machinery was then driven at full power, with the three after propellers working ahead, and the forward propeller astern, or in opposition to the after ones. Under this condition the engines developed 11,250 horse power, a speed of close on 16 knots being attained, or practically the same rate as when all four screws were running ahead. On the completion of these trials the main propelling engines were disconnected, the auxiliary screw engines connected to the shafts, and the ship driven at a slow speed, the results throughout being highly satisfactory.

During the protracted two days' trials of the ship thick weather prevented the section post on the measured mile from being seen, and speed was, therefore, taken by log. The practical result which has been arrived at seems to be that the speed with 8,000 horse power was nearly 15.25 knots. The speed with the three after engines working ahead was about 15.5 knots, and the speed with all the engines running ahead was about 16.25 knots, the power in each case being at the maximum. The highest indicated power developed was 12,000 horse power, and this corresponds with the speed of 16.25 knots. With the three after engines working ahead and forward engine working astern the power was 11,250, of which the forward engine was never developing more than 2,000 horse power.

The *Ermack*, in a trip to the northwest of Spitzbergen, passed through 200 miles of ice of an estimated thickness of about 14 ft.



CROSS SECTION, ELEVATION AND HOLD PLAN OF THE STEEL FOUR SCREW ICE BREAKING STEAMER ERMACK, BUILT IN ENGLAND FOR THE RUSSIAN GOVERNMENT.

DISINFECTING STEAMER SANATOR FOR THE U. S. MARINE HOSPITAL SERVICE.

BY C. M. GREEN, FIRST ASS'T ENGINEER R. C. S., SUPERINTENDENT OF CONSTRUCTION M. H. S.

An interesting example of unusual marine construction is found in the new disinfecting steamer *Sanator*, just completed by the Kensington Engine Works of Philadelphia for the United States Marine Hospital Service.

The efficiency of a floating disinfecting plant has been fully demonstrated, notably by the successful and rapid disinfection of troops and troop ships at Montauk Point in the fall of 1898 by means of the disinfecting barge *Protector*, then just completed for the Marine Hospital Service. Had no such apparatus been available at that time, the spread of disease from the troops returning from Cuba might have been very disastrous.

The disinfecting vessel *Sanator*, now being fitted out for service at the port of Havana, was designed under the supervision of the Bureau of Marine Hospital Service, and is provided with the most improved Kinyoun-Francis disinfecting and fumigating machinery, the whole plant being a decided improvement on that of the barge *Protector* and undoubtedly the most complete floating disinfecting plant in the world.

The *Sanator* is a low powered steam vessel capable of making a maximum speed of about 8 knots, this being sufficient to enable her to reach her station and to move around the harbor as may be required.

CONSTRUCTION OF HULL, ETC.

In construction the hull is framed of Delaware oak, planked inside and out with yellow pine and decked with Oregon pine. The use of wood for the construction of the hull was necessitated by the fact that a steel hull is quickly corroded and eaten away by the solution of bichloride of mercury, which is one of the disinfectants used in considerable quantities on the vessel and which cannot be kept out of the bilge.

The construction of the hull is very staunch and well suited for the purposes intended. The dimensions are as follows:

Length over all	161 ft. 6 in.
Length from forward edge of stem to after edge of stern post	149 ft. 11 in.
Beam, extreme on water line	32 ft.
Depth of hold from top of deck beams at side to top of ceiling at keelson	12 ft.
Depth from top of main deck beams at side to top of keel	13 ft. 3 in.
Camber of deck beams	6 in.
Draft, normal, forward	7 ft. 3 in.
Draft, normal, aft	8 ft. 3 in.
Displacement, normal	640 tons.
Displacement, tons per inch at L. W. L.	9.4 "
Distance center to center of frames	26 in.
Depth of keel below bottom planking	9 in.

The keel is of oak 10 in. by 12 in. in four sections with keyed scarfs secured by copper bolts. The keelson, 10 by 16 in., is of yellow pine, scarfed in three sections. The frames are of oak, sided 6 in. and moulded 12 in. at the throat and 6 in. at the deck. The deck beams are of yellow pine, sided 10 in., 13 in. deep at the center and 7 in. at the ends. They are secured by hackmatack lodging and hanging knees well fastened. The bottom and inside planking is 3 in. thick and the top sides 4 in. thick. The clamps are 4 by 12 in., and 4 by 8 in. planking is carried from the clamps clear down to the lower turn of the bilge and 3 in. ceiling to the keelson. The deck is 3 in. thick, increased to 4 in. under the windlass and around the mast.

The frames are brought up through the plank shear and form stanchions for a heavy rail extending unbroken entirely around the vessel. There is a solid waist with four freeing ports. A heavy guard extends entirely around the vessel at the sheer strake and the sides are kept clear so that other vessels can come alongside without damage.

The stem and apron are made of oak in one piece, sided 10 in. Towing bitts are located near the stem. The hawse pipes are very large, to provide for patent stockless anchors. The stern post is of oak, 12 by 17 in. at the propeller boss and 12 by 10 in. elsewhere. The rudder post is of oak, 10 by 12 in. The rudder is 5 ft. wide, and fitted with heavy composition braces and pintles. The stock is 12 in. dia. of oak. The steering gear is of the double purchase hand pattern. Bilge keels, 8 by 10 in., extending for a distance of 80 ft. amidships, are provided to reduce rolling in a sea way. The hull is coppered to a mean draft of 8 ft. 6 in.

The hold is entirely floored over 12 in. above the keelson, giving a large space for the reception of disinfecting and auxiliary machinery. At each end are raised platform decks to increase the floor space.

There are two cross bulkheads forming between them the infected compartment of the hold into which is taken all baggage, clothing and effects to be disinfected. This compartment contains the forward ends of the two steam disinfecting chambers with the doors, cars and tracks, and also a vat for bichlorate of mercury for disinfecting certain articles by immersion in this solution. Above this compartment is a hatch 8 ft. square from the main deck and also clothes hatches from the two disrobing rooms in the deck house. This compartment is provided with lockers and racks, but is so built as to be easily disinfected or fumigated as may be necessary after infected goods are handled.

Forward of the infected compartment is another compartment also provided with large hatches. This space contains the chain lockers, paint locker, sulphur bins, two large sulphur furnaces with smoke pipes, sulphur pipes, exhauster and engine, two store rooms and two large fresh water tanks, the latter being located under the raised flooring.

The space aft of the infected compartment is the largest compartment in the vessel. In its forward end are the two steam disinfecting chambers, with the formaldehyde gas and ammonia generators, the steam exhauster, cars, tracks, doors and attachments. Goods after being disinfected in the chambers are brought through this compartment and taken up through the after hatch which is 8 ft. square. At the sides abreast of the steam chambers are two fresh water tanks.

Aft of these are two storage batteries for lighting purposes. This storage battery system is believed to be the first ever installed in a vessel for the United States Government. Abaft of these are the ventilating blower and engine on the starboard side and the dynamo room on the port side. This latter room contains besides the engine and dynamo the switchboard and connections and a tool locker. Next to the dynamo room is another large water tank near which is located

the steam fire pump. On the starboard side is an 1,800 gal. tank for bichloride of mercury solution, and near it a special steam pump connected to force the solution through pipes and hose connections to all parts of the vessel or to a vessel alongside, as may be necessary.

Next to these tanks and outboard of the after hatch are the two single ended Scotch boilers, and outboard of these are two more water tanks. Next to these are the two coal bunkers holding together 30 tons of coal. Between the coal bunkers is the main engine, the main feed pump, the water service pump, the condenser, air, and circulating pumps, and feed tank. On the raised platform aft are the pressure supply tank, oil tanks, lockers, work bench and a large ice box and refrigerator.

On the main deck forward is a steam windlass for handling the anchors and also arranged for working the two derrick booms. Aft there is a hand deck pump arranged for use as a bilge or fire pump. A side ladder which can be shipped on either side of the vessel is provided and also a sea ladder.

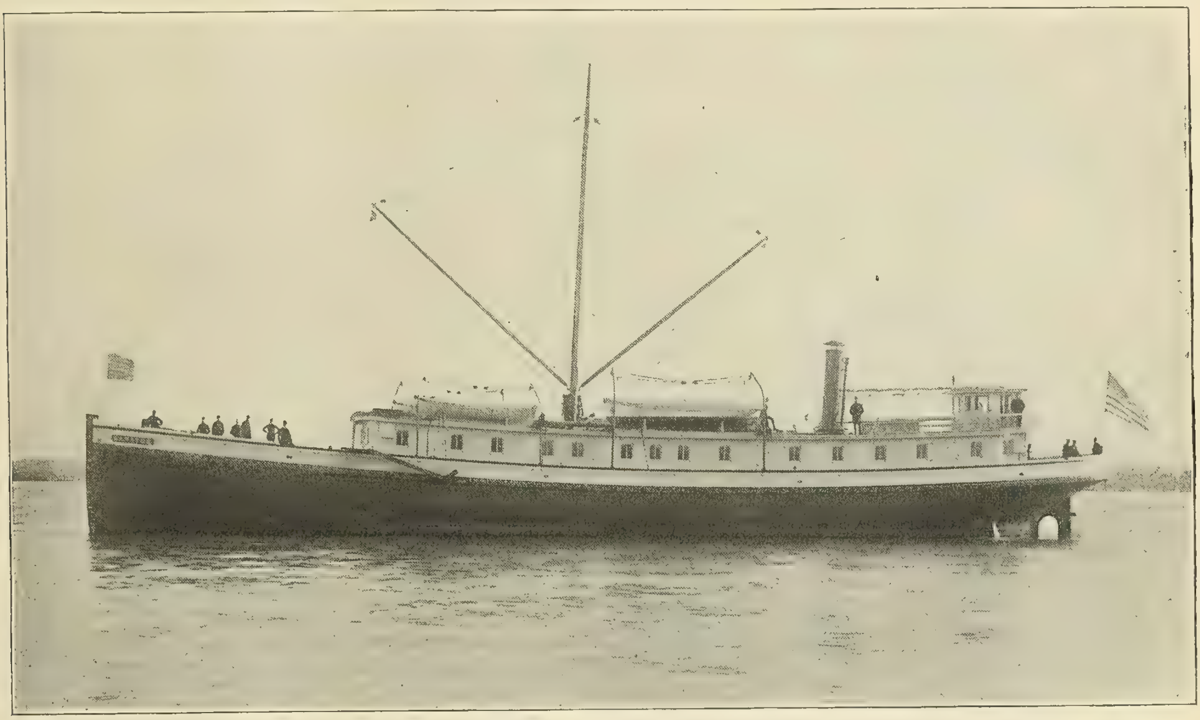
DECK HOUSE.

The deck house, 24 ft. 6 in. wide, extends for a distance of 99 ft. and has an extension at the after end 7 ft. 2 in. long, on which is located the pilot house. It is divided into two parts, the quarters aft and the rooms for handling infected persons forward. A fore and aft bulkhead separates the forward part into two divisions which may be used for males and females as required.

Infected persons are brought on board by the side ladder near the forward end of the deck house. They enter the forward or disrobing rooms, there being one on each side. Their clothing is lowered through the clothes hatches to the infected compartment of the hold, where it is sorted and disinfected, going through the steam chambers and up the after hatch. The persons being treated meanwhile pass from the disrobing rooms to the bath rooms, immediately aft, where are six shower bath rooms and four rooms, each with a tub and shower. After bathing they go to the dressing rooms, where their clothing has been delivered after disinfection. They then pass to the waiting rooms, where they remain until taken ashore or to their vessel.

The after part of the upper deck is provided with awning and benches and can be used by waiting passengers in good weather, there being a stairway connecting it with the waiting rooms below.

The quarters for officers and crew in the after end of the deck house comprise a mess room, nine staterooms, with two berths each; a galley, storage closets and lockers. There are two water closets in the after end of the house and two connected with the dressing rooms.



DISINFECTING STEAMER SANATOR FOR U. S. MARINE HOSPITAL SERVICE AT HAVANA, CUBA.

Besides the eighteen berths in the staterooms, thirty-eight berths are provided in the forward rooms of the deck house. These can be taken down and stowed under the transom seats in those rooms when not required. These berths are for use when passengers are to be detained over night. Two of the staterooms can also be used for this purpose or for temporary hospital purposes.

The pilot house is placed on the extreme after end of the deck house in order to leave ample working space for the two derricks and the sulphur pipes and hose on the upper deck.

A single derrick mast is located midway between the two main hatches, and two booms, one for each

hatch, are provided for handling baggage. These derrick booms are worked by the steam windlass and are designed to lift 1,500 lb. each. The mast is also provided with the necessary rigging for enough sail to keep the vessel out of the trough of the sea in case the machinery should become disabled while going from port to port. The sails and rigging are removed when the vessel is stationed in port.

On the upper deck, in addition to the gear for the derricks, are the sulphur pipes, sulphur hose locker and the boats with their cradles, davits and attachments and also three skylights for lighting the rooms below.

BOAT EQUIPMENT.

The boats carried include one 25 ft. alco-vapor launch and two 18 ft. dinghies. The launch is provided with a 5 horse power engine and is very completely fitted out with all necessary attachments, awning, cork cushions, lines and anchor. The 18 ft. boats are provided with masts and sails.

DISINFECTING MACHINERY.

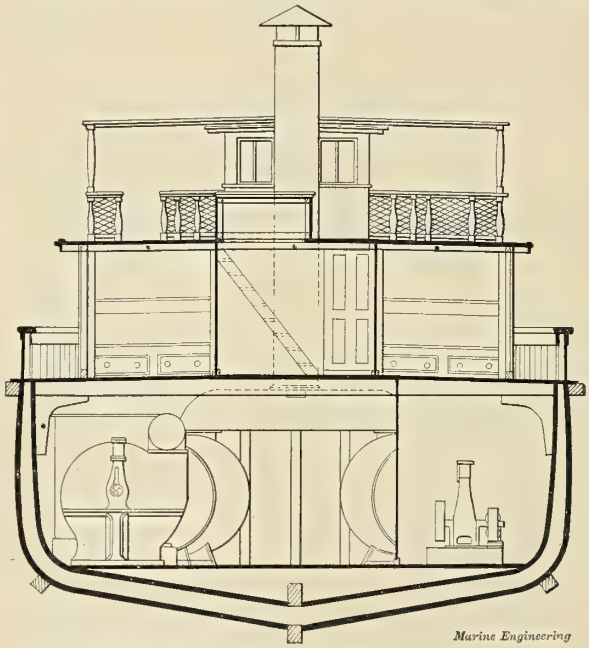
There are two steam chambers located side by side, with their forward ends projecting through the bulkhead into the infected compartment of the hold. In shape they are cylindrical, about 60 in. dia. outside, and 16 ft. long. Each is constructed with an inner and outer steel shell 1 3-4 in. apart, forming a steam jacket, the ends being riveted to heavy cast iron rings and the shells stayed with screw stays. The inner diameter in the clear is 55 in.

At each end is a heavily constructed quick opening door formed of a dished and flanged steel plate 1-2 in. thick. The flange of the door bears against a square rubber gasket fitted in a groove in the cast iron end ring. The door is held shut by heavy steel radial arms bearing against an internal groove in the end ring and against blocks near the outer flange of the door, the inner ends of the arms being held in by a large nut and hand wheel working on a stud at the center of the door. An arrangement is provided for quickly withdrawing the radial arms from the groove in the end ring, thus permitting the door to swing open on a special davit and arm provided for the purpose. Ball bearings are provided in all parts, and although the door is heavy and designed to sustain a total pressure of about 38,781 lb., it can be opened or closed in less than one minute.

The chambers are built to carry a working pressure of 10 lb. per sq. in. They are covered with magnesia covering and are fitted with a complete system of steam and exhaust pipes, drains and traps. A Korting steam exhauster is connected with both chambers, which is capable of producing in either a vacuum of 15 in. in less than one minute.

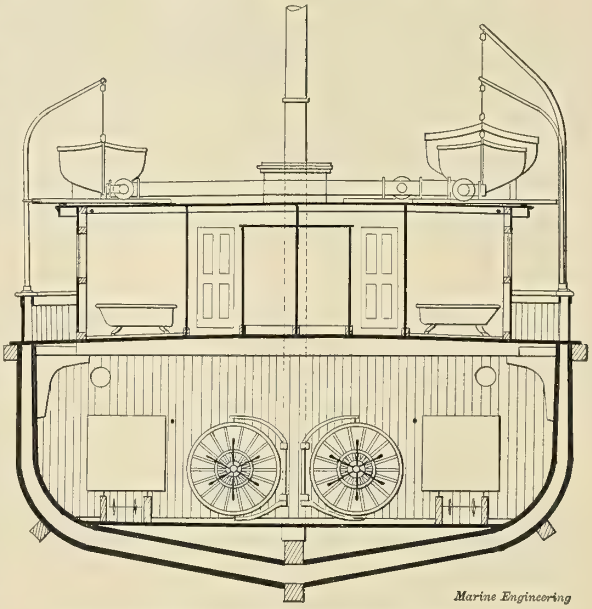
The drainage is led through two steam traps to two drainage tanks under the hold floor, these tanks being emptied overboard by a steam ejector. Steam and vacuum gauges, safety valves and thermometers are provided, and reducing valves are fitted in the steam supply pipes to regulate the pressure. The steam inlet to tne interior of the chamber is at the top, and a copper hood extending the whole length of the chamber is provided to prevent steam impinging directly on the goods being disinfected.

Through each chamber near the bottom runs a double track of angle iron with movable extensions to transfer-tables at both ends. Along these tracks can be moved cars of light wrought iron construction containing the goods to be disinfected. These cars are provided with removable galvanized wire trays, brass



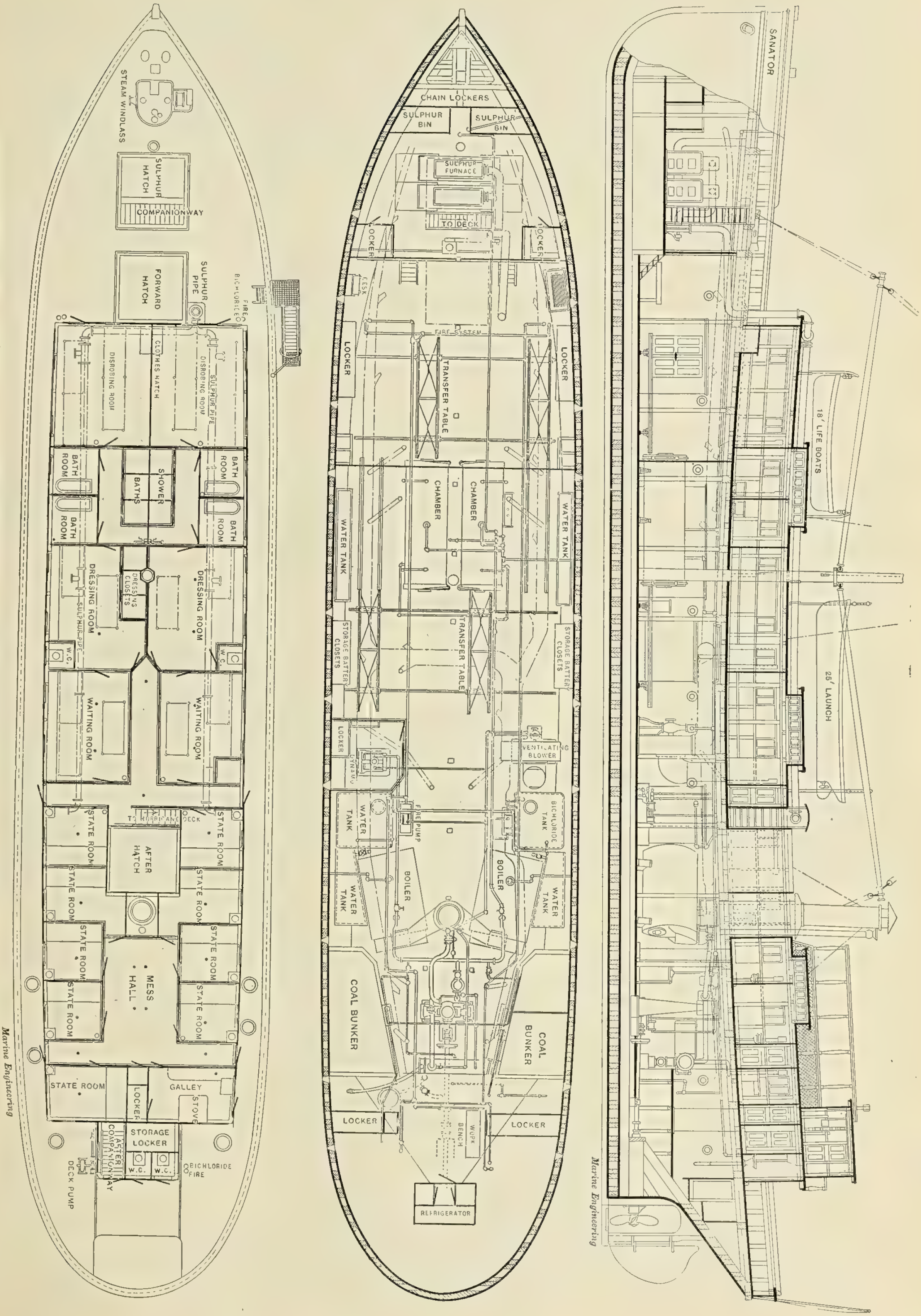
CROSS SECTION OF DISINFECTING STEAMER SANATOR.

hooks, and galvanized wire folding baskets, either of which may be used, depending on the character of the goods being treated. They are loaded with infected goods or clothing while on the transfer-tables in the infected compartment and then pushed into the steam



CROSS SECTION OF DISINFECTING STEAMER SANATOR.

chamber where the disinfection is accomplished. The after doors of the chambers are then opened and the cars brought out on the after transfer-tables where they are unloaded, the disinfected materials being taken up



INBOARD PROFILE, HOLD AND DECK PLAN OF THE DISINFECTING STEAMER SANATOR FOR THE U. S. MARINE HOSPITAL SERVICE AT HAVANA, CUBA.

the after hatch. The cars are then moved outboard on the transfer-tables and taken forward along raised tracks at the sides of the chambers and through doors in the bulkhead into the infected compartment, where they are again loaded with goods to be disinfected. The length of time of the operation depends upon various conditions, but usually occupies about thirty minutes for each chamber. Steam is kept in the jackets of the chambers during the operation, so that the materials disinfected are thoroughly dried before being taken from the chamber. Four cars and four transfer-tables are provided.

FORMALDEHYDE APPARATUS.

Attached to brackets on the side of the starboard steam chamber is an apparatus for generating formaldehyde gas and ammonia gas. It is composed of two generators, one for each gas, secured in one cylindrical casing for compactness and convenience. Each generator consists of a horizontal closed cylinder containing a steam coil and provided with fillers, pressure gauges, safety valves, and proper pipe connections. The cylinder and pipes for formaldehyde gas are made of brass and copper, those for ammonia of cast steel and iron. Each is connected with both steam chambers, the purpose being to use formaldehyde gas for a disinfectant in either chamber when disinfecting any materials which would be injured by steam. The ammonia gas is used after the treatment by formaldehyde gas in order to neutralize the latter and prevent irritating effects on the mucous membrane of the attendants, from inhalation and contact with the goods treated. Either gas is generated by introducing into the generator the proper quantity (computing from the volume of the steam chamber) of formalin or a strong ammoniacal solution, as the case may be, and applying heat by means of the steam coil.

Before using either steam or formaldehyde gas in the steam chambers the air is removed by an exhauster and a vacuum of about 15 in. formed.

The vessel is to be provided with four Kinyoun-Francis autoclaves. These are portable formaldehyde gas generators, and can be taken into the cabins or rooms of a vessel alongside for disinfecting purposes, the rooms being tightly closed to prevent the escape of the gas.

SULPHUR FURNACES.

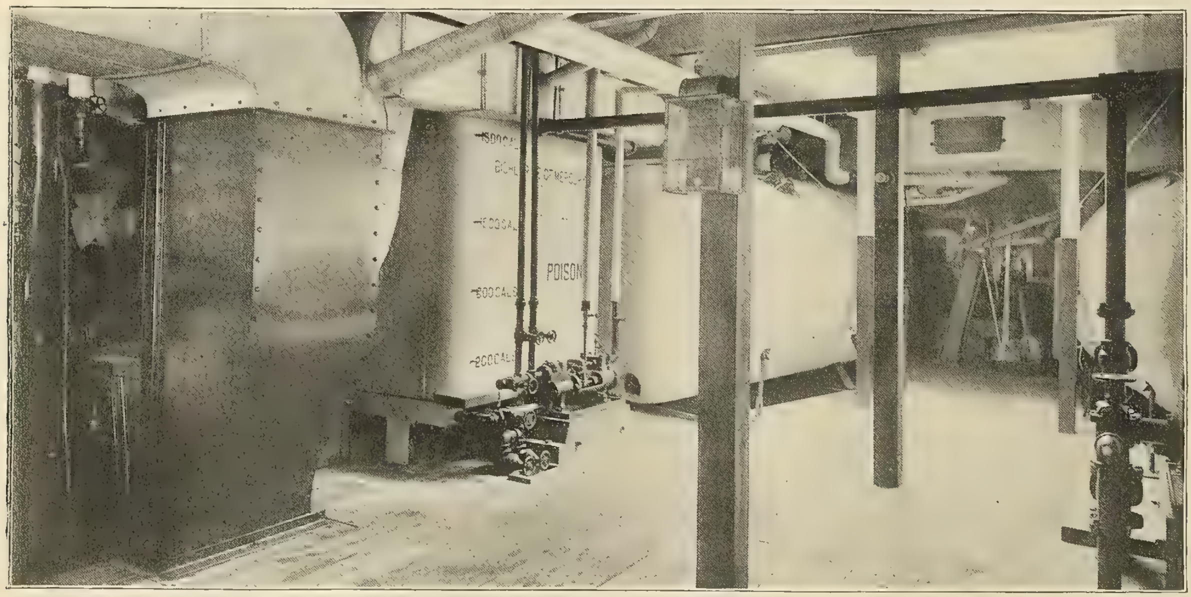
In the forward hold compartment are the two sulphur furnaces side by side athwartship. Each is built of steel with cast iron fronts, the dimensions being: length, 10 ft.; width, 3 ft.; height to top of reservoir, 6 ft. 6 in. There is a fire box at each end of each furnace, over these being shallow cast iron pans for the reception of the sulphur. Dampers and baffle plates are provided to regulate the supply of air and prevent too rapid combustion. On the top is a reservoir where the sulphur dioxide is collected. The smoke from the fire boxes is taken bv a pipe near the bottom to a smoke-stack leading up through the main deck forward.

Pipes from the gas reservoirs connect to a high speed Sturtevant exhausting fan belted to a vertical engine, 5 in. by 6 in. This exhaustor delivers the sulphur gas through a 12 in. galvanized iron pipe leading through the main deck to branch pipes extending fore and aft on both sides of the upper deck. On each of these branch pipes are three connections for special 6 in. sulphur hose, by means of which the sulphur gas can be taken into any compartment of a vessel alongside to be fumigated.

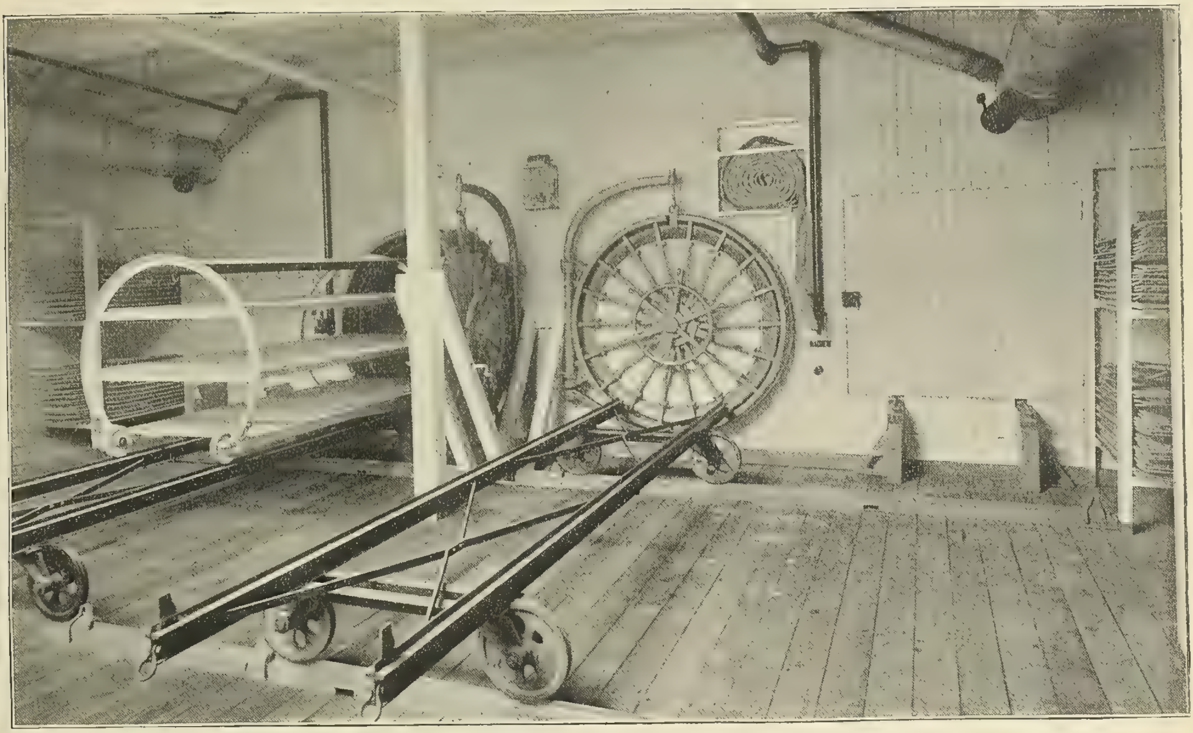
The sulphur furnaces and sulphur piping below the main deck are well covered with magnesia covering and the piping on deck is kept well clear of wood work. The sulphur bins forward of the furnaces hold together 40 barrels of sulphur.

BICHLORIDE OF MERCURY APPARATUS.

An 1,800 gal. steel tank for the storing of bichloride of mercury solution is located in the hold amidships on the starboard side. Above this in the deck house is a 40 gal. mixing tank with connections for steam and water as well as a connection to the large tank



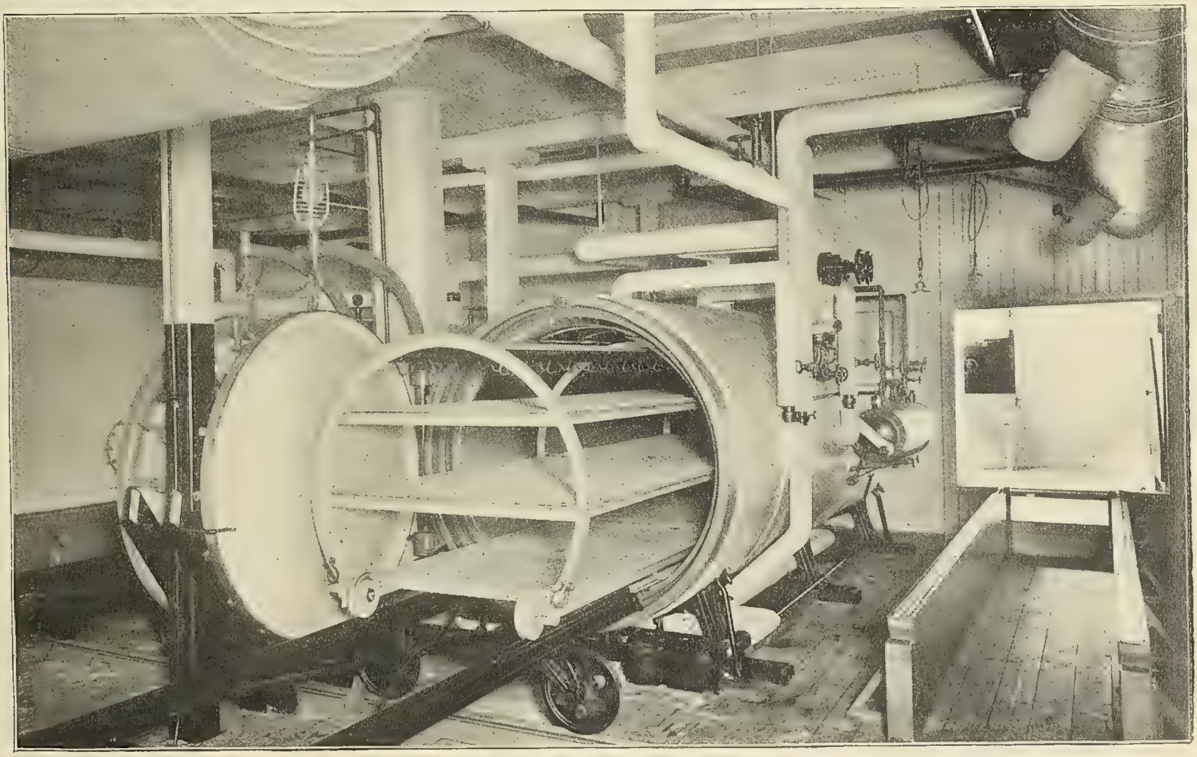
VIEW IN AFTER END OF HOLD OF S. S. SANATOR LOOKING TOWARD STARBOARD SIDE.



FORWARD ENDS OF STEAM DISINFECTING CHAMBERS IN INFECTED COMPARTMENT.

below. The proper quantity of the chemical is mixed in the small tank and allowed to flow into the large tank, into which has already been pumped a quantity of water sufficient to make the required solution.

Near the large tank in the hold is a special horizontal duplex pump, having steam and water cylinders of 4 1-2 and 2 3-4 in. dia., respectively, and a stroke of 4 in., its water cylinder, valve guards and connections being made of iron and the valves of rubber, it having been found that the bichloride solution acts less quickly on these materials than brass. This pump has suction connections to the sea, the bilge, and bichloride tank,



AFTER ENDS OF DISINFECTING CHAMBERS—CARRIAGE PARTLY RUN OUT IN FOREGROUND.

and delivers to the same tank, to the bichloride pipe system, or overboard. Its principal purpose is to take the solution from the tank and force it through the bichloride pipes to hose plugs located on the four corners of the deck house and to two hose plugs in the hold. By means of the 2 in. hose, and spray nozzles, the solution can be sprayed as a disinfectant in any part of the vessel or in any part of a vessel alongside being disinfected.

A bichloride vat is located in the infected compartment, into which articles may be dipped for disinfection.

BATHS AND WATER SUPPLY.

Bathing facilities are extensive; there are ten 10 in. showers and four porcelain-lined iron bathtubs located in the ten bathrooms in the deck house. These are supplied with water through Gegenstrom water heaters, the latter being supplied with thermometers and steam and water regulating valves. The heaters are located outside the bathrooms and the temperature of the water is regulated by an attendant.

The water supply is provided by connections to a pressure tank located on the after hold platform. A horizontal duplex pump provided with an automatic regulating valve supplies this pressure tank with fresh or salt water as may be required. The pump is so arranged as to maintain a constant pressure in the tank automatically. By means of a system of galvanized iron pipes this tank also supplies the nine wash basins in the staterooms and also the galley with fresh water.

The bathrooms and tubs are all provided with drains leading overboard, there being a 3 in. drain pipe on each side for this purpose. The wash basins in staterooms and galley sink are also provided with overboard drains.

BOILERS, ENGINE AND AUXILIARIES.

Two single ended Scotch boilers are placed in the hold outboard of the after hatch and just forward of the main engine. They are built for a working pressure of 110 lb. per square inch and are of the single furnace type. Their dimensions are: Length, 10 ft. 3 in., and diameter, 6 ft. 10 in. The furnaces are 39 in. internal diameter and the grates 6 ft. 6 in. long. The following data is for both boilers:

Heating surface, sq. ft	1,189.18
Grate " " "	42.25
Area through tubes, sq. ft	5.52
Area of smoke pipe, " "	5.58
Ratio, heating to grate surface	28.14
Ratio, grate surface to area through tubes	7.64
Ratio, grate surface to area through smoke pipe	7.57

The smoke pipe is 30 in. dia., and extends 30 ft. above the grates. A steam jet is fitted at the base, and also an exhaust nozzle which can be used when the engine is run non-condensing. A Worthington horizontal duplex feed pump is located on the starboard side of the engine room. It is 6 in. and 4 in. by 6 in., with suction connections to the fresh water tanks, the feed tank, the sea, and the bilge, and delivery both to the boilers and overboard. Two injectors are also fitted.

The main engine is of the inverted direct acting single crank type, with cylinder 17 in. dia. and 20 in. stroke. It is designed to develop 200 I. H. P. at about 150 revolutions. It is fitted with a single ported slide valve, and Myer cut-off gear. Cast iron columns form the framing and to these the slides are secured, the crosshead being T shaped with double pins. The thrust bearing bolts directly to the bed plate. No pumps are fitted to the engine, and the piping is arranged to run the engine condensing or non-condensing as desired. The crank shaft and pins, also the thrust and propeller shafts are 6 1-2 in. dia. Cast iron is used for the propeller, which is of the Trout pattern, a four bladed true screw, 6 ft. dia. and 7 ft. 4 in. pitch.

A combined surface condenser, air and circulating pump is located athwartship aft of the engine. Besides the connection to the main engine the condenser is connected to the auxiliary exhaust pipe, so that the auxiliaries can be run condensing if required.

A steel feed tank, with filter arrangement, 4 ft. 6 in. long, 18 in. wide and 30 in. deep is provided. The fire pump is of horizontal duplex pattern, with cylinders 6 in. and 5 3-4 in. dia. and 6 in. stroke. It is arranged to draw from the sea or the fresh water tank, or from water boats alongside, and the discharge has connections to the fire mains and to the fresh water tanks.

Seven large steel fresh water tanks are fitted, not including the bichloride of mercury tanks and smaller tanks already referred to. The capacity of the seven is 10,000 gallons of water.

LIGHTING PLANT.

For lighting the *Sanator* a Sturtevant direct driven marine set of 6 k.w. capacity is installed in the dynamo room on the port side of the hold. The engine has a cylinder 6 in. by 6 in., and the dynamo is a compound wound eight pole machine, with carbon brushes. Its capacity is 100 16 c.p. incandescent lamps. Slate is used for the switchboard, which contains the usual instruments and also a rheostat for the storage battery, with sufficient range to control from 10 to 70 lamps.

The storage battery, consisting of 60 cells, is located in two special lockers, one on each side of the hold. The lockers are provided with three inch lead vent pipes to carry off the acid fumes. There are 30 cells in each locker. The battery has a capacity sufficient to carry 50 16 c.p. 110 volt lights for 10 hours after being charged. Its total weight is 5,900 lb., including fittings. The weight of each cell filled is about 91 lb., the dimensions being 8 1-2 in. by 8 1-2 in. and 10 in. high. The cells are placed in lead-lined wooden troughs or boxes, there being fifteen cells in each. These boxes are sealed to prevent the acid spilling when the vessel is rolling. Each of the lockers containing the cells measures 2 ft. 8 in. by 7 ft. 3 in., and is 6 ft. 6 in. high.

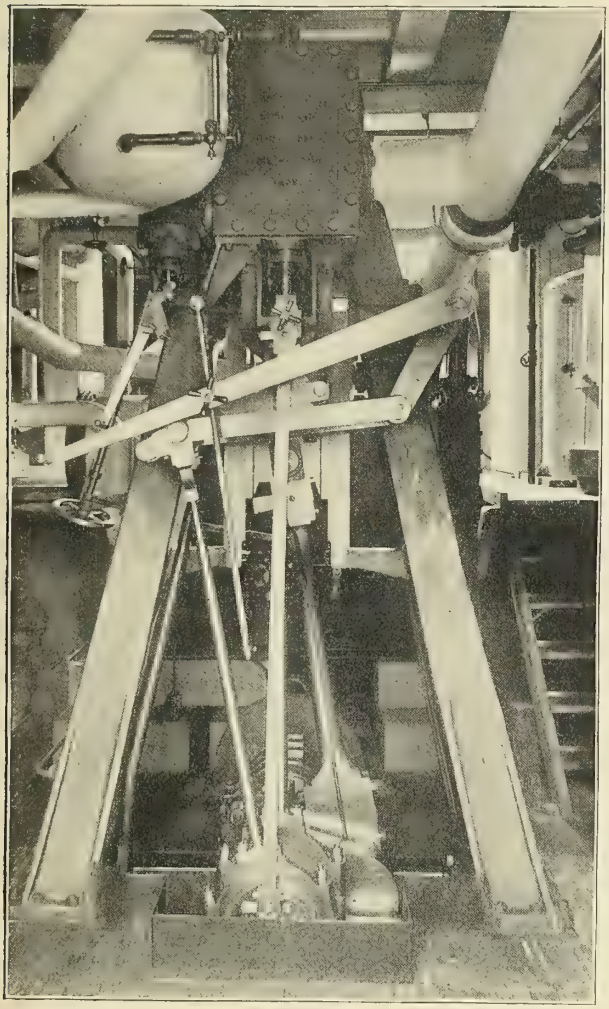
VENTILATING SYSTEM.

The ventilating plant consists of a Sturtevant blower and high speed engine, direct connected. The diameter of fan is 75 in. and its width 26 in. A suction duct 38 1-2 in. dia. passes up into the deck house and takes air through a grating on the starboard side of the house. The delivery pipe from the blower has branches of galvanized iron pipe extending to all parts of the vessel. A delivery louvre is located in each room of the deck house and at intervals on both sides throughout all compartments of the hold.

The ventilating plant is designed to entirely renew the air in all parts of the hold every five minutes, the

designed capacity of the blower being 12,000 cu. ft. of air per minute when it is making about 260 revolutions per minute.

In the way of handling gear and minor appliances there is a combined steam windlass and hoisting engine, two Baldt stockless anchors, a double brake hand deck pump and a bilge ejector.



SINGLE-CYLINDER; SINGLE-CRANK ENGINE, S. S. SANATOR.

There are, of course, extensive storage facilities for the various supplies and disinfecting materials carried, and, altogether, the vessel is as complete as sanitation and engineering science can make it.

Loss of Coast Liner.—The steamship *Gate City*, of the Ocean Steamship Co., on a recent trip from Savannah to Boston, went ashore on the Great South Beach, Long Island. She stranded in a thick fog, about 10.30 o'clock at night. The life saving crew from the Moriches Station took off the women passengers, but the men on board decided to stay with the vessel. They were taken off at a later date, and much of the cargo of cotton was saved. The vessel is expected to be a total loss. On two previous occasions this vessel went ashore, but was successfully floated again. She was an iron steamer, built at Roach's yard, in 1878, of these dimensions: Length, 254 ft.; beam, 38 ft.; depth, 24 ft.; gross tonnage, about 2,000 tons.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—III.

DESCRIPTIONS OF BABCOCK & WILCOX, WATSON AND BOYER BOILERS WITH SECTIONAL DRAWINGS.

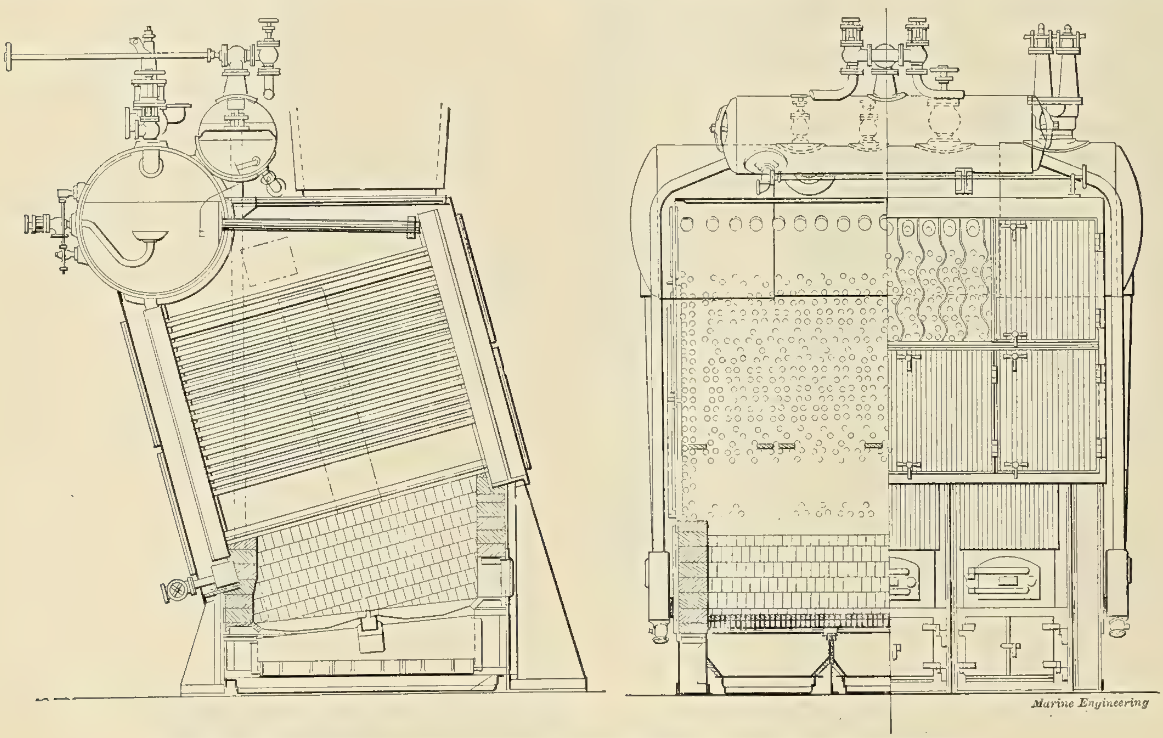
Babcock & Wilcox Marine Boiler.

This boiler is a modification of the old and widely known stationary water tube boiler, which has been in use both here and abroad for more than a quarter of a century. For marine use it has been made in various forms or modifications of one well defined type, and the boiler which we here illustrate is designed for ordinary passenger and cargo steamers. This boiler is of the large, straight submerged tube type. It consists of a series of water tubes, inclined at an angle of about 15 deg. to the horizontal, expanded at the ends in vertical sinuous headers of square or box section. The tubes enter the headers at right angles, and the upper ends are at the front of the boiler. The headers are laid side by side across the front and back of the boiler in pairs, each pair being connected with an inclined row of tubes. The upper ends of the front set of headers project above the top row of water tubes, and are connected with the steam and water drum by horizontal pipes at about the water level. This drum is of large diameter, and is placed over the top of the back set of headers. A short length of pipe connects the bottom of the drum with each of these headers. Each side of the boiler is composed of an inclined row of tubes forming part of the heating surface. Below the water tubes the furnaces are formed of brickwork or fire tiles, and the whole boiler is contained in the usual casing with non-conducting lining. Each of the back headers is connected by a short length of pipe with a mud "drum" of rectangular section, which extends across the back of the boiler at the lowest point reached by the contained water. To the form of boiler here illustrated a feed water purifier and heater is fitted. This consists of a drum of smaller diameter than the steam drum, placed in front of and alongside the latter, and about half way between its horizontal and vertical axes. The feed water enters the top of this subsidary drum midway of its length, and falls in the form of a cascade by means of suitable baffle plates. It is heated by coming into contact with live steam, which is admitted to the purifier by a connection with the steam drum. In the lower half of the feed drum there are a number of diaphragm plates, over which the water passes on its way to the outlet pipes at the ends of the drum. These pipes carry the feed after it has parted with impurities down to the mud drum of the boiler, before referred to. A blow-off is fitted at the bottom of the feed drum, which can be used to clean out the sediment when necessary. When in operation steam is generated in the inclined water tubes, which receive the heat direct from the furnace, and the mixture of steam and water rises in the "uptake" headers at the front of the boiler. From there it passes into the drum by the horizontal tubes, connecting the front headers with the drum, where the steam is liberated and drawn off through the dry pipe in the top of the drum. The return flow is by way of "downtake," or back headers, to the tubes again, and so a continuous circulation is main-

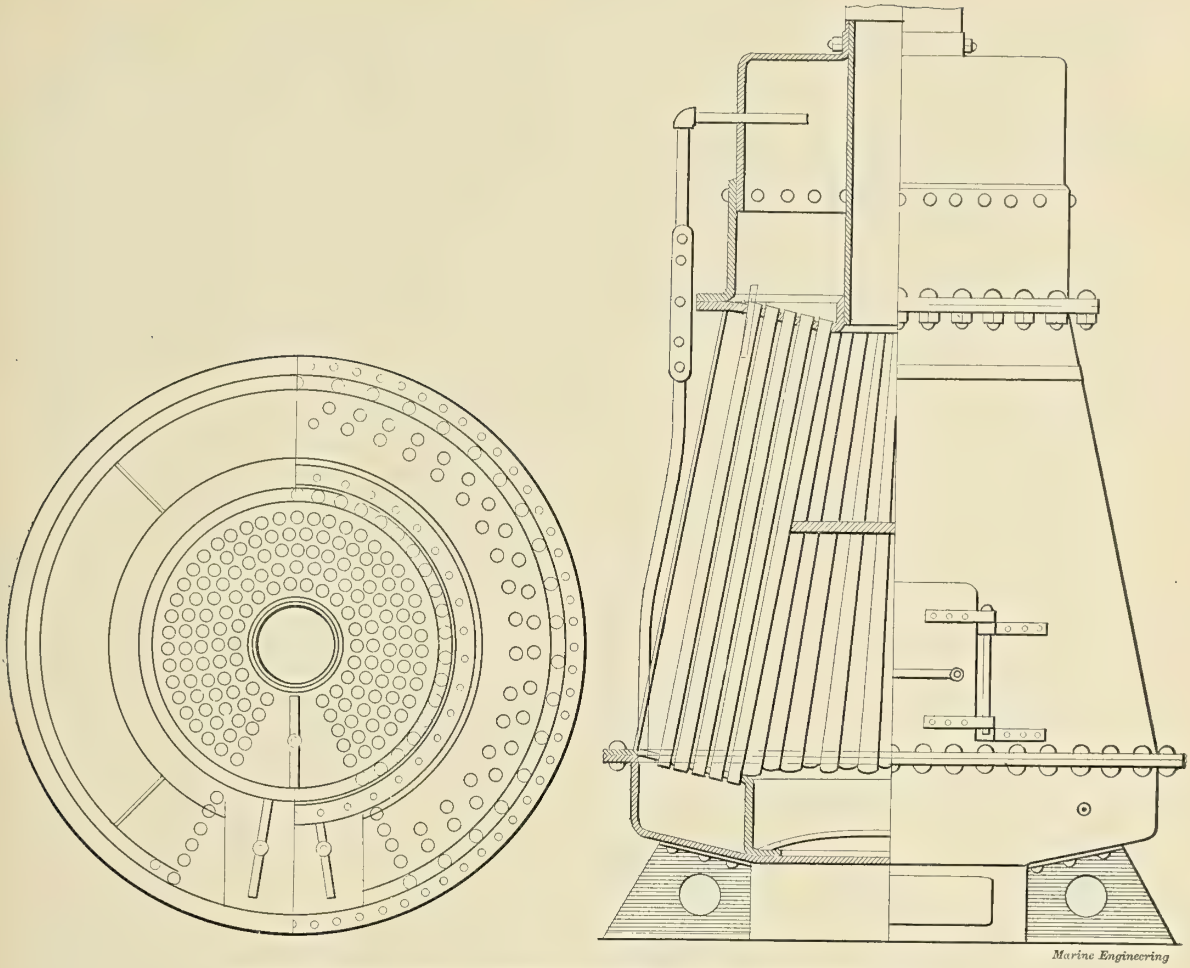
tained. This boiler is constructed wholly of wrought steel. All the generating tube ends are expanded by the ordinary roller expander, and the interior of these tubes can be easily examined and cleaned by the removal of plugs in the headers opposite the ends. Boilers of this general type have been fitted in several merchant vessels on the ocean and Great Lakes, and also in a number of war vessels. In the U. S. Navy they have been already installed or ordered for these ships: *Atlanta, Annapolis, Chicago, Cincinnati, Marietta,* and *Wyoming,* and (stationary type) for the monitors *Canonicus, Mahopac,* and *Manhattan.* They are built in this country by the Babcock & Wilcox Co., 29 Cortlandt street, New York.

Watson Radial Water Tube Boiler.

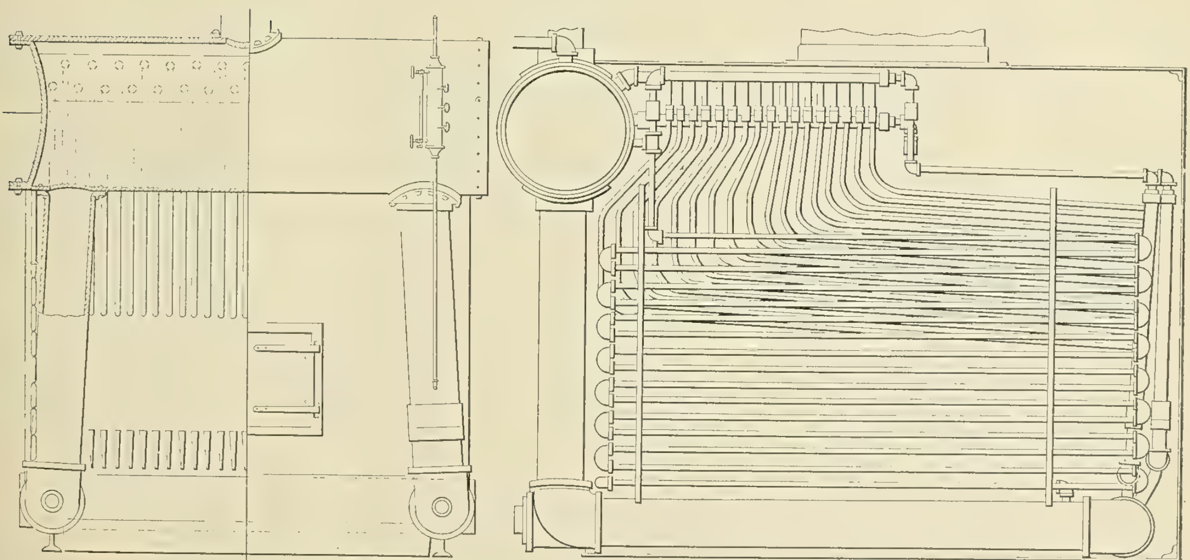
In construction the Watson radial water tube boiler differs considerably from most of the other marine boilers on the market. Its general outlines, when set up ready for use are those of a truncated cone. As shown in the drawings, the tube system is in the form of a cone, inclined over a central furnace, the tubes being straight and expanded at the upper ends into the steam dome, and at the lower ends into the water bottom or reservoir. The tube sheets are inclined so that the tubes enter them practically at right angles. At the bottom the tubes are very widely spaced, and as they converge at the top the spacing is proportionally narrowed here, an arrangement which helps to break up the gases and facilitate combustion. A baffle plate is placed in the upper part of the combustion chamber, directly under the smoke pipe. The latter is in the vertical axis of the boiler and is connected to the upper tube sheet by a screwed joint at the lower end. Where it emerges from the steam dome a metallic slip joint is used, with bolts passing through the neck of the joint at right angles. The water bottom is forged (dished) from one sheet of steel with a circular opening in the center for the reception of the grate, the bars of which are put in through the furnace door. Joints between the lower tube sheet and the shell of the water bottom are riveted and caulked. A cone shaped, sheet steel, air tight diaphragm extends from top to bottom between the rows of tubes designated as steam tubes, and the circulating or down flow tubes, with, of course, an opening for the fire door. Riveted joints are used to connect the various elements as described, with the exception of the flanged joint between the upper tube sheet and the bottom of the water and steam dome. This joint is made with bolts and nuts, and can be readily broken for inspection, cleaning, or repair, such as replacing a tube. In this boiler the circulation when under steam is very rapid. In operation the gases of combustion are deflected among the tubes when they strike the baffle plate on their way from the furnace to the stack. The inner rows of tubes are exposed to the greatest intensity of the heat, and in these the water rises from the bottom reservoir to the dome. Outside the diaphragm, before referred to, the rows of tubes are comparatively cool, and in these the water flows in the contrary direction. The hotter the fire the more rapid the circulation. Solids in suspension in the feed water are carried down to the water bottom and are taken care of by use of the sediment cock. The water is carried well above the tops of the tubes, so that when in operation they are all submerged. In the upper part of the dome the dry pipe encircles the smoke pipe. All material entering into the construction of this boiler is carefully inspected; the tube sheets and dome are of 60,000 lb. T. S. steel, and the tubes are solid drawn. A steel ash pit is bolted to the water bottom, and can be readily re-



SECTIONAL DRAWINGS OF THE BABCOCK & WILCOX MARINE TYPE WATER TUBE BOILER.



SECTIONAL PLAN AND ELEVATION OF WATSON RADIAL WATER TUBE BOILER.



DRAWINGS OF THE BOYER SECTIONAL WATER TUBE BOILER.

moved and replaced. It is claimed for this boiler that it is light in weight and occupies little space, while at the same time having large heating surface and grate area. It also has a low center of gravity. The contained water is about 30 per cent of the total weight of the boiler. The inventor and manufacturer is Egbert Pomeroy Watson, Elizabeth, N. J.

Boyer Water Tube Boiler.

This boiler is of the sectional small bent tube type. It consists of a steam and water drum placed across the front end of the boiler at the top. From the bottom of this drum at each end large down-flow pipes are carried, outside the front casing, to horizontal water legs situated below the level of the grate, these legs extending along the two sides and back end of the boiler. The water legs at the sides are not directly connected to the series of small tubes forming the generating system. From the water leg at the back there rises a double row of vertical tubes or manifolds to a height of about the water level in the drum. From these vertical manifolds the generating tubes extend, with a slight upward inclination toward the front of the boiler, the lowest row of tubes forming the furnace crown. This row extends the entire length of the boiler from front to back, turning upward—inside the front casing—in an easy bend, each tube terminating in a horizontal manifold, which connects at the front end with the drum above the water level. The successive rows of generating tubes are spaced somewhat widely apart in their vertical direction and this brings the topmost row to a connection with the upper manifold, about half the length of the boiler from front to back. Alternate sections of the generating tubes, or "generating flats," as they are termed, connect with horizontal manifolds at a different level. There are two rows of these horizontal manifolds, one entering the drum a short distance above the other, and both above the water line. The back ends of the horizontal manifolds are connected with the top ends of the vertical manifolds at the back by independent tubes or relief pipes, L shaped, and fitted with screwed connections—this is done to prevent dead ends. Across the top of these relief pipes a coil is laid, through which the feed is passed on its way to the horizontal water legs. At each side of the firebox, inside the casing, a row of horizontal tubes, with screwed connections at the ends, is carried from the level of the grate to a point considerably above the furnace crown. At the bottom the row on each side connects with the side leg, and at the top with the steam drum. These details will be clear upon an inspection of the accompanying drawings. It will be noticed that all the small tubes are exposed to the action of the fire, and in these the flow is upward. The down-flow pipes carry the water from the drum to the horizontal water legs, and from there it passes into the vertical manifolds, and thence into the generating system. In operation the gases pass directly over the generating tubes on their way from the furnace to the smoke outlet, which is the center of the top of the boiler. The boilers are built to conform to United States inspection rules, and all the pipes, tubes and fittings used are commercial sizes, such as can be purchased in the open market. The boiler is manufactured by the patentees, L. Boyer's Sons, 90 Wall street, New York.

Stranding of British Sailing Ship.

Residents of the New Jersey coast in the vicinity of Point Pleasant, were treated to the spectacle of a four masted steel sailing ship high, and practically dry, on the beach last month. The vessel, named the *County of Edinburgh*, had almost completed the long voyage from Cape Town to New York, in ballast, when she went ashore in a dense fog February 12. In the photograph, the position of the vessel is plainly seen, with visitors alongside who had walked out to the ship across the sands. Several days after the mishap the crew came ashore, as the vessel was pounding heavily under the influence of the tide and a strong northwest wind. At this time of writing the ship is still fast on the sand, and it is believed that a channel will have to be dredged to get her afloat again, unless she can be lightened sufficiently to float during the next spring tide. The *County of Edinburgh* is a steel ship built in 1885 by Barclay Curle & Co., of Glasgow, Scotland, and she is owned by R. & J. Craig. Her dimensions are: Length, 285 ft.; beam, 42 ft.; depth, 24 ft. Her gross tonnage is 2,160 tons. The ship was under charter to the Standard Oil Co.

Naphtha Launch Saves Steamship.—An unusual decoration has just been added to the 21 ft. naphtha launch *Sachem*, owned by Frederick T. Adams, of New York. It takes the form of a silver plate with an inscription recording its presentation by the underwriters and the New York & Puerto Rico S.S. Co., to the owner, for services rendered by his launch to the S.S. *Ponce*, while in distress off Tybee Island, Ga., in October, 1899. The plate was affixed to the wood work of the launch at the yard of the builders, the Gas Engine & Power Co., and Charles L. Seabury & Co., Con., New York. It was on the maiden trip of the new S.S. *Ponce* that the incident that has this pleasant sequel took place. The steamer left New York for Puerto Rico October 19, with passengers and cargo; among the former being Frederick T. Adams, who brought with him the launch *Sachem*, and the engineer Alex. Ingraves. The *Ponce* met bad weather and when two days out lost her propeller. Sea anchors were got out and the vessel kept bows on to the seas, and finally help came, with a Dutch steamer, which towed the *Ponce* for two days. The weather was getting worse all the time and the vessels parted company. As the condition of the *Ponce* in the prevailing weather was serious, Captain Dyer decided to try and communicate with the shore, less than 50 miles distant. He asked Mr. Adams for the loan of the launch, which was freely granted, and Captain Dyer, with the assistance of the launch's engineer and members of the crew of the *Ponce*—six in all—set out for help. A tremendous sea was running and a gale blowing, but the launch made good headway and put the party ashore at Tybee Island, Ga., in about seven hours. From there the assistance of tugs from Savannah was secured, and the *Ponce* was finally towed into port.

At the annual meeting of the New York Yacht Club held last month, Lewis Cass Ledyard was elected commodore for the ensuing year. As a consequence, for the first time in a number of years, a sailing yacht will be the flagship of the club.

BRITISH SAILING SHIP, COUNTY OF EDINBURGH ASHORE ON COAST OF NEW JERSEY. SEE PAGE 126.

MARINE ENGINEERING

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Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

RESULTS of a careful enumeration of the steel vessels under construction at shipyards on the seacoast of the United States, in the month of January, 1900, have recently been published by the United States Bureau of Navigation. Commissioner E. T. Chamberlain, chief of the bureau, has been engaged in some useful work of late in furthering the interests of the American merchant marine, and the tables just referred to are part of the campaign of education. To those who have not occasion to keep in close touch with the work in the coast yards these official figures must be surprising in magnitude. In all instances it was not possible to secure complete returns, so that there are probably some errors of omission, but nevertheless the total merchant tonnage recorded was little short of 200,000 tons. Additional to this there are fifty war vessels under construction at coast yards of a total of 140,313 tons displacement. This, it must be remembered, takes no account of the large amount of tonnage under construction on the Great Lakes, nor the considerable number of vessels now under construction on our rivers and other inland waters. The lake tonnage on which work is now going forward amounts to about 185,000 tons, and the river yards are very fully occupied, many of the vessels being of the largest size. For the coast and lakes we have then a grand total of more than 500,000 tons under construction. A significant fact, as showing the trend of progress, is that a very considerable amount of this tonnage is first-class full-powered steel construction, designed and equipped in accordance with modern ideas. One group under this head consists of ten steamships, of 81,600 tons, now being built at coast yards for foreign trade, all of the vessels being eligible for subsidy under the ocean mail act of 1891. These vessels include: Two steamers of 11,300 tons for the Pacific Mail; two steamers of 12,000 tons for the International Navigation Co.; three steamers of 7,000 tons for the Oceanic Steamship Co., and three steamers of 4,000 tons for the New York and Cuba Mail. There are also four large freight steamers of 8,000 tons for the new line to the Hawaiian Islands. For the coasting trade there are forty-five steel vessels under construction of a total of 76,000 gross tons. In one yard alone (Newport News) there was, in one stage or another of construction, the enormous total of 102,680 tons, when the list was prepared. At Cramps' the total was about 90,000 tons. The figures given here do not, of course, represent the annual capacity of the various yards, as they include vessels in all conditions, from those just contracted for to those which have undergone their steam trials. At the same time, however, they show the condition of activity which prevails, giving employment to tens of thousands of persons and necessitating the expenditure of a tremendous sum in the aggregate for finished materials. Since the introduction of steam no such activity has before been experienced, and it only needs the helpful aid of Congress to speedily develop this outgrowth of the nation's commercial energy many fold.

IN connection with the maintenance of a large fleet of naval vessels in Asiatic waters, there is no more pressing need than the creation there of proper docking facilities. The acquisition of the Philippine Islands makes it possible to establish such in American waters. There are at present no facilities for docking vessels—other than the very smallest—in our new possessions, and consequently, our warships have to make the long sea voyage to Hong Kong to go into dock. The extra cost and time involved are serious enough, but not nearly as serious as the fact that these docks are under the control of a foreign, if friendly, power. In

case of a war—a possibility, though not a probability—in which Britain would be obliged to remain neutral, the efficiency, or even safety, of our vessels in those waters would be seriously threatened. In the late war, owing to a combination of fortunate circumstances, our vessels in the Orient did not suffer greatly for lack of such facilities; but the outcome of that war did not grant us immunity from serious injury in perpetuity. Long before the Manila fight the Spanish Government recognized this very need and made a contract with a concern at Newcastle-on-Tyne, England, for the construction of a floating dock for the port of Olongapo, P. I. Work on this dock was begun and carried forward, but before completion the Spanish-American war had broken out and delivery was never made. We understand that this dock has since been completed and is now for sale at the builder's yard. According to authentic reports at the time the contract was let, the dock was to be of large size, capable of lifting any vessel up to 500 ft. long, and 12,000 tons displacement. It was to be self docking and equipped in all respects according to the best modern practice. The dock was to be built in sections so that it could be readily shipped to its destination and there finally put together. A dock of these dimensions can hardly be classed as a readily salable article, and it is not unlikely that it could be purchased by the United States Government at a reasonable price, though on this point we have no information whatever. It would certainly not be very long before the cost of such a dock would be expended in sending our naval vessels to Hong Kong and paying docking charges there. If, all things considered, the purchase of this particular dock was inadvisable, the authorization by Congress for the immediate construction here of a floating dock for the Philippines would seem to be a very necessary act.

PUBLISHED returns of the world's shipbuilding during 1899 show a grand total of merchant vessels of 2,122,000 tons, of which 1,946,000 tons were steam and 176,000 tons sail. In these columns last month we gave a summary of the British returns which, as is customary, are the largest. Next in amount of output comes the United States with 225,000 tons, a very considerable increase over the tonnage put out during the year preceding (1898). Germany comes third, but not far behind, with 211,000 tons; France fourth, with 90,000 tons, and Italy's total foots up nearly 50,000 tons. It is noticeable how small the percentage of sail tonnage has become of the total output. In 1899 there was not a single sailing ship built in the United Kingdom, and but for the additions made by France to the sail tonnage the total would have been considerably less. Under the stimulus of State aid the French built no less than twenty-four sailing vessels, none of less than 2,000 tons, and the largest exceeding 3,000 tons. Outside the United Kingdom the total number of mercantile vessels built was 292 steamers of 530,945 tons, and 251 sailing vessels of 174,002 tons, and the total of war vessels was 56 of 176,170 tons displacement. During the year the total amount of tonnage lost, broken up, or otherwise removed from trade, was 727,000 tons; made up of 345,000 tons of steam vessels and 382,000 of sailing vessels. This means the decrease of all sail tonnage, throughout the world, by about 200,000 tons, and the increase of steam tonnage by about 1,600,000 tons.

AN announcement was made by the trustees of Columbia University last month that the decision had been reached to establish courses in marine engineering and naval architecture in the School of Mechanical Engineering. Coupled with this was the very extraordinary public statement, attributed to President Seth Low, that he "shared the opinion of the faculty that it is highly important for the University to pre-empt the field of marine engineering without delay." We can hardly believe that President Low was quoted correctly, for such a choice of expression, as ordinarily understood, would imply either an astounding ignorance of facts, or a desire of the faculty to slight two of the most successful and honored scientific schools the world over—the Massachusetts Institute of Technology, and Sibley College, Cornell University. In both these technical colleges courses of study in naval architecture and marine engineering have long been established, and have been the means of educating a corps of young men, the influence of whose training is now being felt most beneficially in the upbuilding of the American merchant marine. In a quiet, unostentatious way these splendid schools are doing a work which, when their graduates shall have matured and risen to places of executive responsibility, will go a long way toward establishing this country as the foremost shipbuilding nation in the world.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—V.

BY DR. WILLIAM FREDERICK DURAND.

§3. CORROSION. [Continued.]

The possibility of deposits of copper on boiler surfaces has been already mentioned. These were first noted in connection with the corrosion accompanying the general introduction of the surface condenser. It was believed that the copper of the condenser tubes was attacked by the pure water resulting from the condensation of the steam, or by the fatty acids formed as above explained, and was then carried over into the boiler and deposited on the surfaces. To prevent such action the condenser tubes were tinned, thus covering the copper from the action of the water or the fatty acids. Neither this step nor the substitution of hydrocarbon oil for that containing fatty acids has made any very marked difference in boiler pitting, and at the most the presence of the copper can have been only one among a number of causes as suggested.

There has been much difference of opinion and difference in experience regarding the question whether wrought iron or steel boiler tubes were the more liable to corrosion. It was pointed out that wrought iron was less homogeneous than steel, and therefore the latter should be the better. The early experience with steel hardly bore out this claim, and in fact the general opinion seems to have been that wrought iron tubes were found to corrode less readily than steel. In explanation of this, it may be said that while wrought iron was less homogeneous physically, the steel was perhaps less homogeneous chemically, and in any event contained a larger proportion of carbon than the iron, so that it would by no means follow that it would necessarily be less subject to electro-chemical action. The latest and best products of the steel makers for such purposes, however, are extraordinarily low in carbon and very homogeneous, and experience with such grades of material seems to show them superior to wrought iron in this respect.

We have thus developed in some detail the causes of corrosion on the water side of steam boilers, so far as they are understood. For the prevention of such effects their causes must be removed or counteracted.

For reducing the amount of oxidation and the possible results due to electro-chemical action, the presence of air in the feed water must be avoided by preventing as far as possible the entrance of water from overboard into the feed. The hot-well or feed-tank should also be of good size and kept full, so that there may be no danger of its getting too low from time to time, and thus allowing the pump to take air. The piston rod on the low pressure cylinder should be kept well packed, so as to prevent the entrance of air during the exhaust part of the stroke. The feed pump rods on the water end should be kept well packed for the same reason.

To prevent acid corrosion the formation of the acids must be prevented as far as possible, and such as may form must be neutralized within the boiler. The prevention of the formation of fatty acids has been considered above. We have also seen that the formation of other acids is due chiefly to the presence of salts contained in sea water, or to organic substances. We have therefore simply an additional reason for keeping all such substances out of the boiler as far as possible. To neutralize such acid as may form, bicarbonate of soda, or soda-ash, as it is known in the trade, may be used from time to time, and in such quantities as may be found necessary. To test the water for acidity the litmus test is used. Blue litmus paper turns red when dipped in water slightly acid, while if the water is alkaline it remains blue, or the red color caused by an acid is changed to blue. By this means the condition of the water may be tested from time to time and soda used accordingly. Care must be taken not to use it in too great excess, as it may cause foaming. The soda is introduced by means of a soda cock on the condenser. Instead of keeping the water alkaline by the use of soda, dependence is often placed on the zinc slabs used to prevent electro-chemical corrosion. These are gradually dissolved, forming zinc chloride, and this will undoubtedly tend to neutralize free acids and to keep the water alkaline. Whether sufficient or not, can of course be readily determined by the litmus test before referred to.

For the prevention of electro-chemical action the causes must also be removed or neutralized as far as possible. This cannot be realized entirely, but it is clear that the results will be the better as the following conditions are the more nearly fulfilled:

(1) The structure of the boiler should be of material as homogeneous as possible in its chemical constitution and physical condition.

(2) Causes liable to produce oxidation or the presence of foreign substances should be kept out of the boiler as far as possible.

(3) The water in the boiler should be made as nearly neutral or non-exciting relative to the iron as possible. This in a general way will be attained by keeping it slightly alkaline rather than acid, and by avoiding very high densities.

In addition to these means for reducing the causes, there remains one further step, and that is:

(4) The provision of a substance which shall be electro-positive to iron, and readily attacked, so that the activity will be diverted from the iron to the protecting substance, and the operation will proceed at the expense of the latter rather than of the former. Such a substance we find in zinc, and its use for this purpose is very general and seemingly beneficial.

It may be also noted that the formation of zinc chloride as referred to in the foregoing will aid in keeping the water alkaline in reaction, thus reducing its natural activity, and contributing further to the general decrease of electro-chemical action.

In order to be effective as a protection to the iron in the manner described, the zinc must be in actual metallic contact with the structure of the boiler. It is usually in the form of rolled or cast slabs, weighing 8 to 12 lbs. each. These are often placed in perforated sheet metal baskets hung from the stays or attached to other portions of the boiler. Where the basket is attached to the boiler there should be *bright metal* contact, and the attachment should be by screwed joint or other equivalent means, so that the separation of the two surfaces by

the formation of scale or corrosion between them may be prevented. The zinc should also be connected to the basket by through bolts or other means which will insure continuous metallic contact. In some cases the zincs are hung by a through bolt without other means of support. In such case, as the zinc becomes used it may fall apart and the pieces may lodge where they will obstruct the circulation, or be otherwise undesirable. In any event they will no longer protect the part of the boiler confided to their care, and their period of usefulness may therefore be less than when supported and connected to a basket as described above. The number of zincs fitted varies greatly according to the judgment of different engineers. In some cases not more than 10 or 12 would be assigned to the protection of a large double end boiler, while in others as many as 40 or 50 would be used. The latter number is the better representative of good modern practice. In any case they should be distributed as nearly uniformly as possible throughout the boiler, in order that the latter may be thus subdivided into parts, each more especially under the influence of a given slab.

Instead of depending on zinc to prevent or divert electro-chemical action, as above described, some engineers prefer to depend simply on reducing the activity of the water by keeping it alkaline by the use of soda, introduced as the litmus test may show to be necessary.

When spots are found in a boiler, showing the presence of pronounced corrosion, they should be cleaned off thoroughly, washed with soda solution, and, if not on a heating surface, covered with a thin wash of Portland cement. This will attach itself to the iron and protect it in a manner similar to the lime scale.

The beneficial effect of scale in thus protecting the surfaces of boilers from corrosion is well recognized, and there is no doubt that its presence as a thin wash or layer is of great value. In order to be effective, however, it must be so firmly and closely attached to the iron as to prevent contact of the water with the surface, else the corrosive action may proceed under the scale and result all the more seriously because it is protected from inspection until the scale is thoroughly removed. On the tubes and other heating surfaces of the boiler with their changes of temperature and consequent expansions and contractions, the scale is especially liable to be cracked off or partially separated from the iron, with possible results as here noted. This is still more likely to be the case as the scale becomes thicker and the metal more liable to become overheated. It has also been suggested that a very heavy scale may result in an overheating of the metal sufficient to decompose the moisture present, thus liberating oxygen and forming the magnetic oxide of iron or black mill scale (Fe_3O_4). This is highly electro-negative to iron, and thus it may give rise to harmful electro-chemical reactions.

Laying Up Boilers.—When boilers are to be laid up, the principles already explained will indicate the nature of the means suitable for preventing corrosion.

On the outside, paint or other like coating may be used as already noted. On the fire side of water-tube boilers protection is sometimes gained by building a slow fire of tar or resinous material, the tarry smoke from which condenses on the tubes and furnishes protection from the air with its moisture and carbon dioxide. Use is also made of quicklime in trays renewed from time to time. This absorbs the moisture and so keeps the air dry.

On the inside, all boilers when laid up should be either empty or entirely full. If a boiler stands for any considerable length of time partly full, corrosion is likely to occur about the water line. If they are to be out of use for a short time only, they may be filled full of water made slightly alkaline by the addition of soda, the condition of the water being determined by the litmus test already referred to. If they are to be laid up for a longer time it is better to lay them up dry. To this end the water is removed, the manhole-plates taken off and the interior thoroughly dried out by the introduction of trays of burning charcoal or coke. The boiler is then closed up except a lower manhole through which a tray of freshly burning charcoal is introduced, and the manhole cover is put on. The charcoal will consume most of the remaining oxygen, and the boiler will thus be protected. Instead of the final introduction of a tray of charcoal, trays of quicklime may be used to insure the absence of all moisture, and the boiler then closed as before.

It is readily seen that these various methods are simply ways of carrying out the necessary conditions for preventing oxidation, as already discussed, and if these principles are kept clearly in view, the means most conveniently at hand may be suitably adapted to provide the protection desired.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XXII.

BY WM. BAXTER, JR.

METHODS OF DISTRIBUTION.—CONTINUED.

In the last article several arrangements were shown for connecting the distributing mains with the generator terminals, and the manner in which calculations are made were also briefly outlined. Although only a few examples were given, these should be sufficient to enable any one to apply the principles to any case, for the course of procedure is always the same. Stating the rule in as few words as possible, we can say that to obtain the resistance in ohms of any feeder all we have to do is to divide the volts by the amperes. If we desire to transmit any given current over a line we first determine what loss of pressure can be allowed; that is, what the line drop must be, then we divide this drop in volts by the current, and the result is the resistance of the line. As a rule, it is desirable to keep the line loss as low as possible so as to not waste power, for all the volts absorbed by the line resistance represent just so much coal burned for which no light is given. In many cases, however, the loss of energy in the lines is not of so much importance as the obtaining of uniform voltage at the lamps, hence in deciding what particular type of connection to use these matters have to be considered, but after the plan of wiring has been decided upon the process by which the resistance of the wire is obtained is the same.

In the last figure of the last article we showed a method of connecting the distributing mains with the generator in such a way as to be able to deliver a higher pressure at the distant lamps than when a single con-

nection is made, and it was pointed out that by the plan shown the voltage supplied to the lamps the furthest from the generator could be greater than that

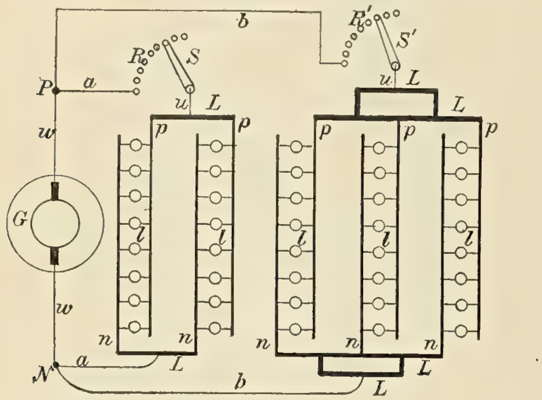


FIG. 140.

of those near by. In Fig. 140, here presented, an extension of the same principle is shown in which the

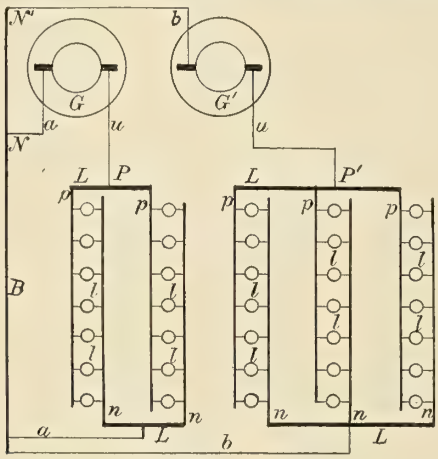


FIG. 141.

voltage delivered to the lamps can be increased or decreased as desired. In some cases it is necessary to

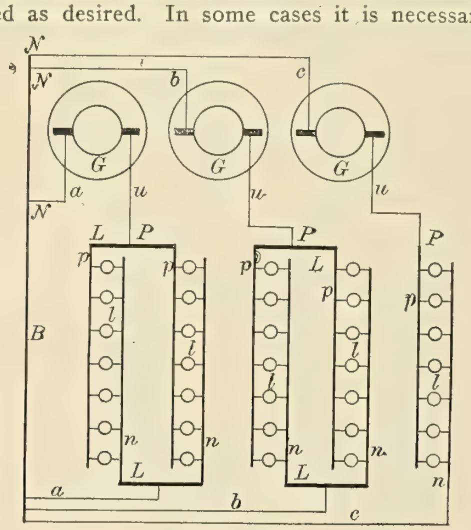


FIG. 142.

arrange lamps so that they may be dimmed without being turned out. To accomplish this all that is required is to reduce the voltage acting upon the lamps, and the simplest way of doing it, when there is only one generator in use, is by introducing extra resistance into the circuit. Thus, in the figure, if we desire to dim the lights in the first and second groups, we turn the switch S so as to cut into the current a portion of the resistance of the rheostat R. In the same way if we desire to dim the last three groups we cut in a portion of rheostat R'. This arrangement is

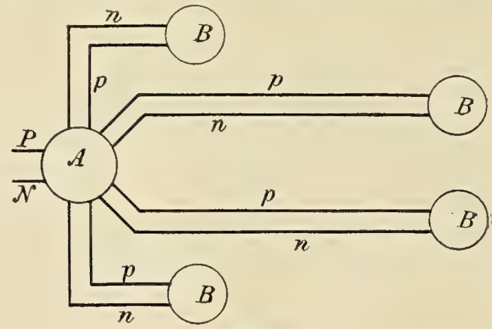


FIG. 143.

not generally liked by engineers, as the introduction of resistance into the circuit involves a waste of energy, but, after all, the waste is not so much as at first might be supposed, for including the portion absorbed by the resistance, the energy supplied to the circuit is less than when no resistance is used. To illustrate, suppose we have sixteen lamps in the first two groups,

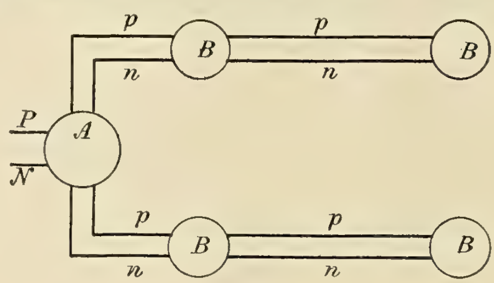


FIG. 144.

taking one-half of an ampere each, making a total of 8 amperes. Let the resistance of each lamp be 224 ohms, then the resistance of the whole number will be 14 ohms, since $224 \div 16 = 14$. Let the resistance of the lines between the terminals PN and the lamps be one-eighth of an ohm, then the pressure of the generator at P and N must be 113 volts, and the lamps will receive 112 volts. Now, suppose we introduce as much resistance of rheostat R as may be necessary to cut the current down to six amperes, we will then find

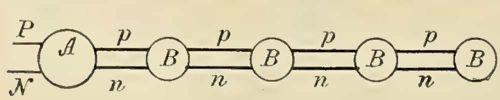


FIG. 145.

that the total circuit resistance has increased to about 18.8 ohms, and of this amount the rheostat supplies about 4.7 ohms, or say, 25 per cent. With the current at 8 amperes, the energy supplied to the circuit will be 113 volts $\times$ 8 amperes $=$ 904 watts, and with the current at 6 amperes it will be three-quarters of this amount or 678 watts, and the portion lost in the rheostat will be 169 watts. Thus we save 226 watts of energy, but

to effect the saving we throw away in the rheostat 169 watts; that is, if we could cut the current down without using the rheostat we could save this 169 watts also. If we have two or more generators we can accomplish the last result by resorting to the type of connection shown in Fig. 141. With this arrangement, as the two generators are only connected to the same circuit on one side, the voltage of either one can be changed without affecting the other one; hence, if we wish to dim the lights in the circuits fed by either machine, all we have to do is to reduce its voltage. This we can accomplish by means of the field regulator, in the manner explained in previous articles. The plan shown in Fig. 141 can also be made use of to reduce the size of wire for the lamps situated at a distance from the generators, because the machine G' can be adjusted to run at a higher voltage than the other one, the difference being made as much as the length of circuits may demand. In any case, however, only a slight difference will be required; thus if the G machine develops a pressure of 110 volts between P and N, the other generator may develop 112 between N' and P'.

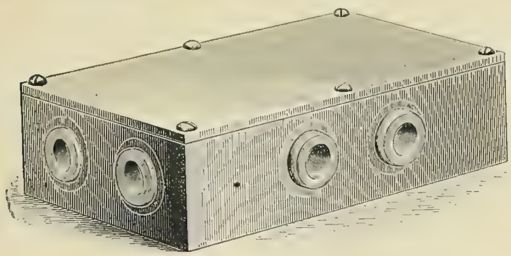


FIG. 146.

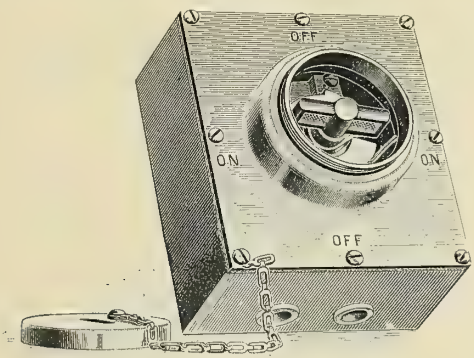


FIG. 147.

If there are three generators, as in Fig. 142, they can be arranged as shown, so as to divide the system of circuits into three sets, and then each machine can be set for a slightly different pressure. Even if the difference in voltage is great it will make no difference in the running of the machines, providing there is no chance for one circuit to be crossed by the other; but if the wires run in such a way that those of one set are liable to come in contact with those of another set, there is a possibility of damage being done, as then the high pressure current would run back through the generator delivering the low pressure and under certain conditions the results would be disastrous.

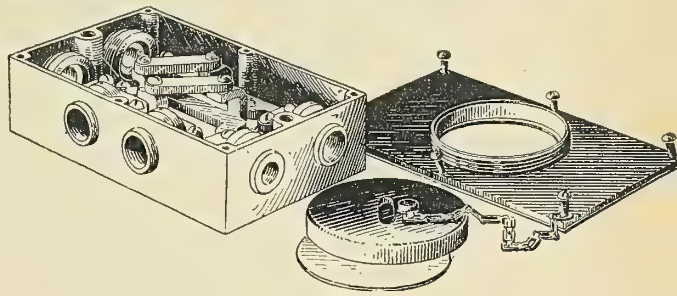


FIG. 148.

Although a certain amount of wire can be saved by dividing the system of circuits into sections, and feeding each one from a different generator, with the pressure increased slightly, for those supplying the more distant sections, the plan is not a desirable one, all things considered, as the saving is effected at the expense of reliability. If all the generators feed into the same system, at the same pressure, the disabling of one machine will not stop any particular section, but at the most will cause a slight reduction all around. With the generators arranged as in Figs. 141 and 142 the whole system can be thrown into one whenever desired by equalizing the pressure of all the machines, and then making the necessary connections at the switchboard. If this is done, however, the lamps on the distant portions of the lines, which are arranged to operate with a higher pressure, will be decidedly dimmer than the normal.

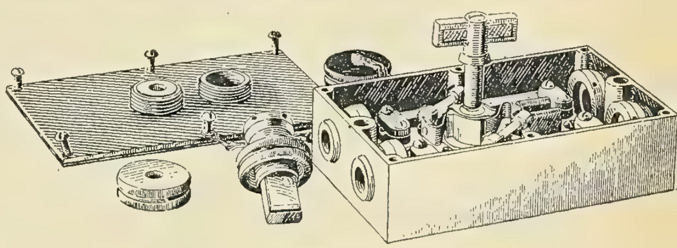


FIG. 149.

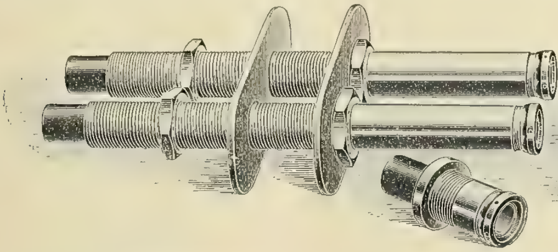


FIG. 150. FIG. 151.

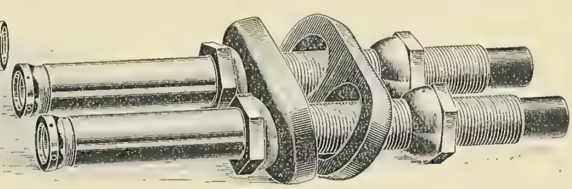


FIG. 152.

In distributing currents over large networks of wires, it is necessary to use a considerable amount of ingenuity to not get them so mixed up that they be-

come a hopeless puzzle. The safest way to avoid such a condition of things is by concentrating the various branch lines into centers of distribution, thus laying out the entire system much after the manner in which the branches of a tree lead out from the trunk. These centers are variously called distributing boxes, junction boxes, distributing panels and panel boards. The general arrangement of these can be understood from Figs. 143 and 145. In the first, figure *A* represents a main distributing box, which is connected with the switchboard by means of the mains *P* and *N*. From this box circuits *p n* run out to the secondary boxes *B B*, which latter form centers from which the lines that feed the lamps are run. The box *A* as well as boxes *B B* may be very simple affairs, or they may be diminutive switchboards. If of the simple type, the main lines *P N* of box *A* may be connected with the four circuits *n p*, with fuse wires in one or both of the wires of each secondary circuit. In this case the overloading of any one of the branches will melt a fuse at *A*, and this fact being known, if the current fails, this portion of the system is at once examined and a new fuse put in. The box *A* may be provided, in addition to the fuses, with switches, by means of which the current may be cut off from any circuit, and then from this point the lamps operated from the boxes *B B* can be controlled. The secondary boxes *B B*, if provided only with fuses, cannot be used to control the individual circuits leading out to the lamps, and in that case they serve principally as receptacles for the safety fuses of the several lamp circuits. If these boxes are provided with switches to control the several lamp circuits, then from them all the lights operating in any one branch can be turned on or off by the movement of a single switch.

Generally it is desired to so arrange the wiring that each circuit will be as nearly independent of all the others as is possible, and to accomplish this result the lines *p n* are run out directly to the *B B B B* boxes, as in Fig. 143; that is, each box is on a separate circuit. Sometimes it is not desirable or practicable, for one reason or another, to run out individual circuits to each secondary box, and in such cases they can be arranged as in Fig. 144 with two boxes in series in each circuit, or as in Fig. 145 with all the boxes in series in the same circuit. This last arrangement would not be adopted very often unless there were one or more lamp circuits running out of *A*, as well as the *n p* circuit running to the secondary boxes. If there were no such additional circuits, the mains from the switchboard might just as well run directly to the first *B* box, and thus dispense with the *A* box.

The distributing boxes and switches used in marine work are made water tight, whenever this construction is practicable, which is almost always the case when they are not complicated, and therefore not large. Large panel boards with many switches have to be made much the same as those used in other lines of work, though, of course, these can be enclosed in protecting cases.

Figs 146 to 154 show several designs of distribution boxes, switches and brushings for running lines through decks and bulkheads, made by the General Electric Co., specially for marine work. Fig. 146 is a simple junction box. Fig. 147 is a double pole switch of the water tight type. Fig. 148 is a similar type of box that is provided with outlets for two distributing circuits. Fig. 149 is a junction box provided with a switch and a plug to take off the distributing circuit. Fig. 150 shows the construction of a main deck stuffing tube, another design being shown in Fig. 152. Fig. 151 is a bulkhead stuffing box for a single wire; the other tubes are arranged in pairs, but can as well be made single.

ENGINEERS' DICTIONARY.—XXV.

Joint—In its general sense, any form of fastening or mode of connecting parts of a machine or engineering structure. Where the parts are to move one relative to the other, some form of *pin, hinge* or *toggle* joint is employed. For stationary parts the term may refer to some particular mode of fastening, as a *bolted* joint or a *riveted* joint, of which there are many varieties. Reference may also be made to some particular mode of preparing the surfaces or making the joint tight against leakage, as a *ground* joint, in which the surfaces are fitted, the one to the other, by grinding them together with some abrasive between, as ground glass or fine emery; or again, a *scraped* joint, in which the surfaces are carefully prepared by hand scraping and dressing until an accurate fit is obtained. The joints between a cylinder head and cylinder, boiler manhole covers and their seats, various bonnets and their seats, etc., are usually made tight with some form of sheet packing, compressed by the fastenings, though occasionally a wire or gasket of copper or other soft metal is employed.

Journal—That portion of a shaft which is supported in the bearing. Care should be had to distinguish between the *journal* which turns and the *bearing* which supports.

Junk Ring—In early engineering practice the name given to the FOLLOWER PLATE (which see). This name was applied because in early practice pistons were made tight by junk or hemp packing secured by this ring.

Key—A bar of metal used as a fastening for securing one piece to another, as, for example, the eccentric sheave on the crank-shaft, the propeller on the tail-shaft, or, with a gib, the connecting-rod-strap to the rod. See under ECCENTRIC, Fig. 51, and also under GIB.

Keyway—The groove cut for the insertion of the key, partly in each of the two pieces to be secured together. See Fig. 51.

Kingston Valve—A name given to the injection or inlet valve for any pump which draws water from the sea, or more especially to the inlet valve for the main circulating pump.

Knot.—The unit of *speed* usually employed in all maritime and naval matters. A speed of one knot is equivalent to a speed of one *nautical mile* per hour. The nautical mile is somewhat differently defined in different countries. Thus in Great Britain it is 6,080 feet. In the United States it is defined as the length of one minute of arc on a great circle of a sphere having the same area as the earth. With the accepted values this gives a length of 6,080.27 feet. The difference between the English and American values is unimportant for ordinary engineering purposes. Taking 6,080 ft. as the

value, it follows that a speed of one knot will represent 6,080 ft. per hour, or 101.33 ft. per minute. To reduce knots to feet per minute we may, therefore, multiply by 101.33. It should not be forgotten that the term *knot* signifies in itself a speed, and that the phrase *knots per hour* is unnecessary. A speed of "15 knots" is the correct way of speaking, rather than "15 knots per hour."

Lagging—A covering placed about steam cylinders. valve chests, steam pipes and boilers, to prevent the escape of heat and often to add a finished appearance to the object thus covered. Steam cylinders and valve chests are usually lagged with strips of wood. In small engines they are sometimes covered with polished brass. Steam pipes, boilers, etc., are usually covered with some one of the many varieties of felt or similar non-combustible material. See FELT.

Lap—When a slide valve is in mid position, as shown in Fig. 84, the amount *AC*, by which the edge of the valve extends beyond the edge of the port on the steam side is called the *steam lap,* and similarly the amount

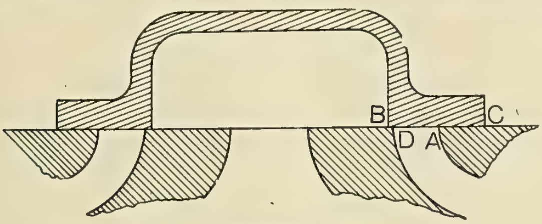


FIG. 84.

BD, by which the edge of the valve extends over the port on the exhaust side is called the *exhaust lap.* While the lap is usually the same at both ends of the valve, this is by no means necessarily the case, and in the most careful designs they are usually different at the two ends.

Lap Joint—One of the varieties of riveted joint in which the two plates lap over each other.

Latent Heat—Heat which is absorbed by a body without effecting a change of temperature. When, for example, heat is applied to water at an ordinary temperature, the first effect is to raise the temperature until the boiling point is reached. At this point the temperature remains stationary and a further addition of heat effects a gradual change of state from water to steam at the same temperature. The heat which is thus absorbed in effecting a change of state is known as *latent.* In a similar way heat is absorbed and rendered latent by the melting of ice, and, in fact, by the passage of practically all bodies from solid to liquid, and from liquid to vapor. The amount of latent heat for the change of water to steam varies with the temperature of the boiling point, and is one of the quantities given in steam tables for the use of engineers. At atmospheric pressure it is 966 heat units, the unit being the amount of heat required to raise the temperature of water one degree, or, more exactly, from 62° to 63° Fah.

Lazy Bar—A bar placed across the opening of the furnace or ash-pit upon which the firing tools are rested in working the fire.

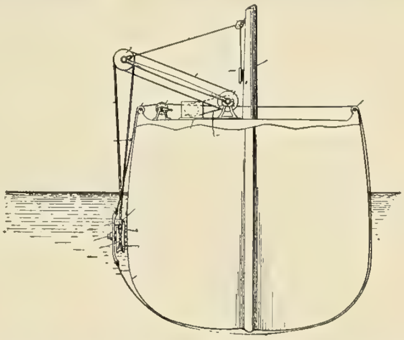
In an 80-page book bound in flexible covers the Power Publishing Co. has issued a reprint of a series of lectures and articles on the subject of condensers, which have appeared in the columns of *Power.* The price is only 50 cents.

SELECTED MARINE PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

633,873. Apparatus for cleaning hulls of vessels. David Mason, New York, N. Y.

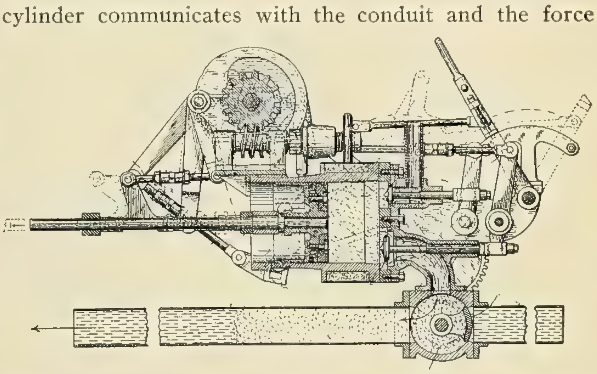
CLAIM.—A rotary disc carrying scraping points is supported against the hull by ropes passing entirely around the vessel. Belt gearing connects the disk with



a motor on the deck of the vessel, so as to impart a rotary motion thereto and cause the points to remove all barnacles from the hull.

634,217. Means for marine propulsion. J. A. Secor, New York, N. Y.

CLAIM.—Propels the vessel by means of the reactionary force of an explosive gas, acting on water in a conduit extending fore and aft the vessel. The explosion-cylinder communicates with the conduit and the force



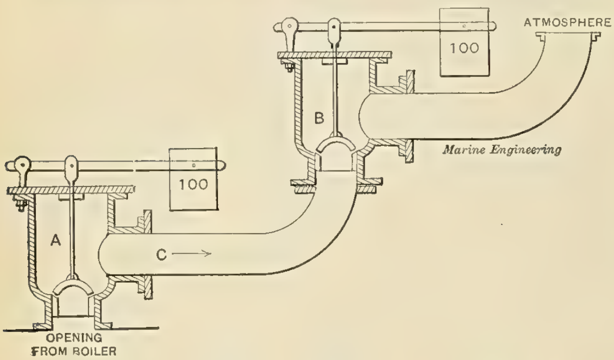
of the explosion drives the water from the conduit. An arrangement of valves and operating mechanism opens the conduit to fill the same while the charge of gas is being drawn in and compressed, so that the greater period of time in the cycle of operation is used to prepare the gas and water for action.

Any one engaged in hydrographic work will find the book entitled "Practical Nautical Surveying and the Handicraft of Navigation," by Commander Thomas A. Hull, R. N., a most valuable assistant. This work of 60-odd pages first appeared as a reprint of two papers read before the Royal United Service Institution in London by the author, and the demand for it was such that the papers have been re-written and issued in the present convenient form. It contains a great deal of valuable information, up-to-date and easy of comprehension. This book—price 3 shillings—is published by J. D. Potter, Admiralty Chart Agent, 31 Poultry, London, E. C., England.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Referring to the accompanying sketch, will you please say at what pressure the safety valves would blow off? These are the dimensions of each: Area of valve opening, 12 in.; center of weight to center of



fulcrum, 36 in.; weight of ball, 100 lb.; weight of valve and stem, 10 lb.; weight of lever, 40 lb.; distance of fulcrum to valve, 5 in. INQUIRER.

A.—With the arrangement you figure, each valve, alone, would blow off at about 73 lbs. With the two valves together the valve *A* will first rise at about this pressure and admit a little steam into the space *C* between the valves. As soon as the pressure in *C* rises slightly, the valve *A* will seat itself and remain until the pressure in the boiler again rises, so that the difference between the pressure in the boiler and in *C* is 73 lbs. In this way the pressures in the boiler and in *C* would gradually rise, their difference keeping at about 73 lbs., until finally when the pressure in *C* is about 73 lbs. and that in the boiler about 146 lbs. the valve *B* will open as well, and there will be an escape of steam to the atmosphere. It would thus appear that if the pressure in the boiler were maintained at about 146 lbs. the pressure in *C* would hold at about 73 lbs., and both valves would blow off more or less regularly, and thus discharge the steam into the air.

Q.—A small launch, L. W. L., 23 ft.; beam, 3 ft. 6 in.; draft, 2 ft., is driven by two 15-in. dia., 30-in. pitch, wheels running at 800 revolutions. They are on the same shaft turning against each other. Will you please tell me whether the speed is figured as one wheel, or if there is a different formula? The boat is so designed in the buttocks that when the bow rises at extreme speed she comes on to a level bottom. The immersed form is designed to offer least resistance, the water lines being extremely fine. I figure out that one wheel will give 16.78 knots, using only 15 per cent. slip. G. S. R.

A.—The information which you give is not sufficient for a satisfactory examination of the problem. The I. H. P. proposed or developed is not given, nor the fore and aft distance between the wheels, nor the nature of the connection between the two motors.

You are correct in saying that a wheel of 30 in. pitch with 15 per cent. slip and making 800 revolutions per minute would drive the boat about 16.8 knots. The question is, however, whether one 15-in. propeller or two such propellers as described in your letter, would be able, even if the necessary power were provided, to develop the thrust necessary to drive a boat of the size given at such a speed with only 15 per cent. slip. It is one thing to specify diameter, pitch, revolutions and resulting speed, but quite a different one to realize it all in practice.

It is very sure that one such propeller would not, nor is it at all likely that two rigged as you describe would be able to realize the conditions imposed, and develop the speed mentioned. There is little or no public experimental data available for estimating the propulsive thrust of propellers coupled up as you describe, and it is not a matter which can be safely figured from the performance of the same propellers singly. In any event, however, it would appear that for the given wheels and revolutions you are probably expecting too much speed, or for the given speed and slip your wheels are far too small.

It is also probable that you could do better with two propellers on the same shaft run in the same rather than in opposite directions, and very possibly also by the use of different pitches and diameters instead of the same. All this is, however, practically unknown ground in the problem of propulsion, and advance can be made only by the gradual accumulation of reliable data through experimental trial.

Q.—Will you kindly explain, through your query column, the caliber of a gun? For example, a "5-in. 50 caliber gun?" W. E. J.

A.—The caliber of a gun means the diameter of the bore. Thus in the phrase a "5 in. 50 caliber gun" the caliber or diameter of the bore is 5 in. The term "50 caliber" refers to the *length* of the bore, and means that its total length is 50 calibers, or 50 times 5 in. It has become customary in modern ordnance to express the length of bore in terms of the caliber, and thus we have had 30 caliber guns, 40 caliber guns, etc., meaning in each case a length of bore of 30, 40, etc., times the caliber.

This answers the question, but a few additional points may be of interest.

The bore of modern ordnance is, of course, rifled. The depressions are termed *grooves* and the intermediate spaces *lands*. The caliber is the diameter of the circle just touching the lands, and is therefore less than the diameter of a circle bounding the bottom of the grooves. In other words, the caliber is the diameter of the original hole before rifling.

The calibers used in U. S. Naval ordnance are 13 in., 12-in., 10-in., 8-in., 6-in., 5-in. and 4-in. Below about 4-in. caliber the gun is usually referred to by weight of projectile, and in U. S. Naval ordnance we have the 12-pounder of about 3 in. caliber, the 6-pounder of about 2.3 in. caliber, the 3-pounder of about 1.8 in. caliber and the 1-pounder of about 1.5 in. caliber. In countries other than England and the United States the caliber is expressed in the metric system and usually in centimeters for large ordnance, and in millimeters for rapid-fire and small guns. Many of the latter are found in the U. S. Naval ordnance. Thus the 37 mm. gun corresponds to the 1-pounder, the 47 mm. to the 3-pounder, while the 53 mm. throws a shell of about 4 lb. weight.

For a convenient and simple approximate relation between the calibre in inches and the weight of the projectile in pounds we may use the following:

Rule.—Cube the caliber in inches and divide by 2. The result will give the approximate weight of projectile in pounds.

Thus for the 6-in. gun the cube is 216 and ½ of this is 108, while the actual weight of projectile is 100.

Referring again to the length of gun, there has been in recent years a constant increase in length corresponding to the demand for increasing muzzle velocities About 15 years ago, when the first of the new naval ordnance was built, muzzle velocities of about 2,000 ft. per second were the highest in use, and the length was commonly about 30 calibers. Now the development of a higher velocity at the muzzle means one or both of two things: (1) A higher pressure developed in the gun and hence a greater force acting on the projectile; (2) a longer time during which the force may act. The pressure which can be allowed cannot, however, be increased much beyond the present limits of from 15 to 17 tons per square inch, so that increasing velocities must depend largely on a greater time of action on the projectile, and this means a longer bore within which to allow such increased action. At the same time much depends on the powder, which should be such as to keep up a constant evolution of gas and thus follow up the projectile as nearly as may be with the full pressure so long as it remains in the gun. This requirement led first to the change from black powder to the brown or slow burning powder, the purpose being to obtain a powder in which the rate of combustion could be controlled by the composition, size, density and form of grain, so as to insure the continuance of the full accelerating force as just stated. The still more modern chemical or smokeless powders fulfil still more completely the same requirement, and have the additional advantage of making little or no perceptible smoke.

The latest guns designed for U. S. Naval ordnance are of about 50 calibers length, and with smokeless powder the expectation is a muzzle velocity of about 3,000 ft. per second.

MARINE ENGINEERING.

Vol. 5. NEW YORK, APRIL, 1900. No. 4.

U. S. STEEL SHEATHED PROTECTED CRUISER ALBANY, BUILT AT ELSWICK.

On this page we present a reproduction of an instantaneous photograph of the U. S. cruiser *Albany*, taken while on her trial trip in British waters recently. This vessel, as our readers are no doubt aware, is a sister ship to the U. S. S. *New Orleans*, both vessels having been purchased in England shortly before the breaking out of the Spanish-American war. The *Albany* was constructed at the Elswick yard of Armstrong, Whitworth & Co., Newcastle-on-Tyne, under the supervision of Assistant Naval Constructor H. G. Gillmor, U. S. N.

The speed trials of the *Albany* were carried out January 9 and 11 last, Lieut.-Com. J. C. Colwell, U. S. N., the naval attaché in London, representing the U. S. Government. On the first day's trial there was a stiff breeze, and on the second day a heavy swell was encountered. An average of about 20 knots was the result of the trials, and Lieutenant-Commander Colwell reported his belief that the vessel could have shown 21 knots maximum if needed, as on the full power trial the engines worked easily and the boilers were blowing off during the greater part of the run. Lieut. Com. G. F. W. Holmes, U. S. N., accompanied by other naval officers and men, has gone to England in the U. S. S. *Prairie* to bring home the *Albany*.

U. S. S. ALBANY, 3,700 TONS, DOING 20 KNOTS ON HER TRIAL TRIP.

Originally both the *New Orleans* and *Albany* were laid down at Elswick for the Brazilian Navy, and indeed the *New Orleans* was ready for sea and flying the

Brazilian flag when re-commissioned as an American war vessel in March, 1898. As war with Spain was then impending the *New Orleans* was brought across the Atlantic with as little delay as possible, the crew being furnished by the U. S. S *San Francisco* then on the European station. For this reason no changes were made in the accommodations on the *New Orleans* and she was not an ideally comfortable vessel for North Atlantic service. There was no heating system on board, the quarters were very cramped, and such inconveniences as the marking of all gear in the Portuguese language were numerous. As work on the *Albany* had not far advanced, and there was no possibility of delivery during the Spanish war, there was opportunity to adapt the vessel to our service. Various minor alterations were therefore carried out on this vessel under the direction of the Naval Bureaus at Washington. In the case of the *New Orleans* also complaints were made as to her stability and this led to a series of inclining experiments, carried out at the Brooklyn Navy Yard some time ago. These experiments showed that while the vessel was tender she was perfectly safe under normal conditions, and no fears are entertained now for the safety of either or both vessels.

The U. S. S. *Albany* is classed as a steel sheathed protected cruiser, and is of these dimensions: Length, 346 ft.; beam ,43 ft. 9 in.; mean draft, 18 ft.; displacement, 3,769 tons. She is fitted with twin screws, driven by triple expansion engines of 7,500 I. H. P., and has a normal coal capacity of 500 tons. She is armed with six 6-in. and four 4.7-in. (British caliber) rapid fire guns in her main battery, and ten 6-pounder and eight 1-pounder rapid fire guns and two automatic guns in her secondary battery. She has also three torpedo tubes. Her protective deck is of a maximum thickness of 3 in., and armor of 4.5 in. thick affords protection on the gun positions. The *Albany* was launched January 14, 1899.

S. S. Kaiserin Maria Theresia.—When the North German Lloyd S. S. *Kaiserin Maria Theresia* reached New York last month on her westward trip, few would have recognized in the magnificent liner the old familiar *Spree*, so great a metamorphosis had she undergone. The new vessel is indeed a remarkable example of the present day possibilities in vessel construction. The practically new vessel is of these dimensions: Length, 546 ft.; beam, 52 ft.; depth, 37 ft.; gross tonnage, 7,800 tons. She has accommodations for 330 first cabin, 140 second cabin and 400 steerage passengers, and carries besides a crew of 290 all told. The twin screws are driven by triple expansion engines of 17,000 I. H. P., which are expected to give a sustained speed of 20 knots. The engines have cylinders, 43 1-2 in., 67 in. and (2) 77 in. dia. by 63 in. stroke. All shafting in the vessel is of nickel steel and the propellers are of bronze. They are three bladed and are 18 ft. 4 1-2 in. dia. In addition to the main engines there are 38 auxiliary engines with a total of 66 steam cylinders. Steam is generated in nine double ended boilers, 15 ft. 4 in. dia. and 18 ft. 7 in. long, and four single ended boilers of the same diameter, and 10 ft. 3 in. long. In the passenger quarters the decorations and furnishings are unusually magnificent. In exterior appearance the vessel has a fine appearance in the water.

ON THE LAUNCH OF A BRITISH BATTLESHIP FROM A GOVERNMENT DOCKYARD.*

BY H. R. CHAMPNESS, CHIEF CONSTRUCTOR, R. N.

INTRODUCTORY.

The author offers some remarks on this subject partly upon the suggestion of the president, and also because the members of the institution will naturally be interested in what was a considerable feat in engineering, and, at the same time, a striking development of the resources of the port in which the summer meeting is being held. The launch was that of Devonport's first modern battleship, H. M. S. *Ocean*,† the first since the days of wood shipbuilding, the preceding ship having also been named *Ocean*, and launched as long ago as 1863. How great the advance was will be understood from the fact that the weight of the present ship as launched was 7,110 tons, the nearest approach to this being a steel cruiser, whose launching displacement was 2,830 tons, sent off the same slip in November, 1890. When it is remembered that a very few years since the opinion was seriously expressed that battleships could not be built at Devonport, while, during the last twelve months, three such ships have been upon the blocks, two of which are now afloat, the third well advanced for launching, and a fourth soon to be laid down, it will be admitted that the development promises to be permanent. (See Fig. 1, H. M. S. *Ocean*.)

It is true that this is not a record weight even for battleships launched from the Imperial Dockyards, and it has been far eclipsed by what was lately done in launching the steamship *Oceanic*, when 11,000 tons slid into the water, though the mean pressure per square foot of the cradle was only 2.35 tons, as compared with the 2.5 tons of the *Ocean*; but those most closely responsible for ship launching have little desire to create records of this sort, and certainly, so far as the chief constructors of the Naval Dockyard are concerned, the builders of the *Oceanic* are welcome to their pre-eminence.

BUILDING SLIPS.

An incidental evidence of the growth in dimensions of modern ships is seen in some of the naval yards, where the building slip has been adapted for launching the present ships of great beam and flat floor by cutting away the sides of the slip at the lower end to enable the full section of the ship to clear it. This was avoided at Devonport by increasing the width of the slip throughout sufficiently to provide for all probable increases of beam; the slip was also lengthened at the upper end, and two concrete piers 25 ft. wide were built at the lower end in wake of the launching ways, to carry the ship into deep water when the fore end of the cradle

*A paper read before the Institution of Mechanical Engineers, England.

† Since this article was written H. M. S. *Ocean* has been placed in commission on the Mediterranean station. She is a vessel of 12,950 tons displacement, of these dimensions: Length, 390 ft.; beam, 74 ft.; draft, 25 ft. 5 in. She is fitted with twin screws, driven by triple expansion engines of 13,500 collective horse power. Steam is supplied by Belleville water-tube boilers. Her armor is Harveyized steel, ranging in thickness from 12 in. downward, and her armament includes four 12-in. breech loaders, twelve 6-in. rapid firers, and many smaller guns. She has also five torpedo tubes, four of which are submerged. Her trial speed was in excess of 18 knots.

left the groundways. How well these old slips were piled is clear, since, in spite of the enormous increase of weight borne beyond what could have been dreamed of when they were first prepared, no sign of subsidence of any kind was discernible, though periodical tests for it were made, and the structure was carefully watched.

BUILDING DECLIVITY.

The declivity of the keel in building was 5-8 in. to the foot, and about as usual for a ship of this size, and that of the groundways, or foundation on which the cradle carrying the ship slides, was 51-64 in. to the foot. The longitudinal section of this surface was a circular arc, and had a "camber," or round up, of 9 in. in a length of 300 ft. This prevented the groundways becoming hollow under compression due to the weight of the ship and cradle, and so increasing the difficulty of launching, though there is, perhaps, no absolute necessity for this in naval yards where the floor of the slip is of granite or other hard stone upon a thick bed of concrete. It is, however, desirable that the form of the groundways should have some effect in holding the eration, and the clearance between the keel and the bottom of the slip at this point, generally from 1 ft. to 2 ft., determines the height at which the foremost block shall be laid for building, and taken in connection with the building declivity, enables the blocks to be laid correctly, in view of the launching conditions. It is further necessary that this height of blocks should be sufficient to allow room on top of the groundways for the section of cradle shown in Fig. 15, including the bilgeway, the wedges or "slices," and the solid timber between them and the slip which is known as "stopping up," and had a minimum depth of about 6 in. The length of the groundways must be such as to secure that the ship and cradle shall not tip about their after end, and to determine this certain calculations were necessary, the results of which are shown in Fig. 2.

CALCULATION OF SHIP'S LAUNCHING WEIGHT.

The approximate date of the proposed launch determined the time the ship would be upon the slip, and the local circumstances as to available labor, coupled with building experience, enabled an approximation of the

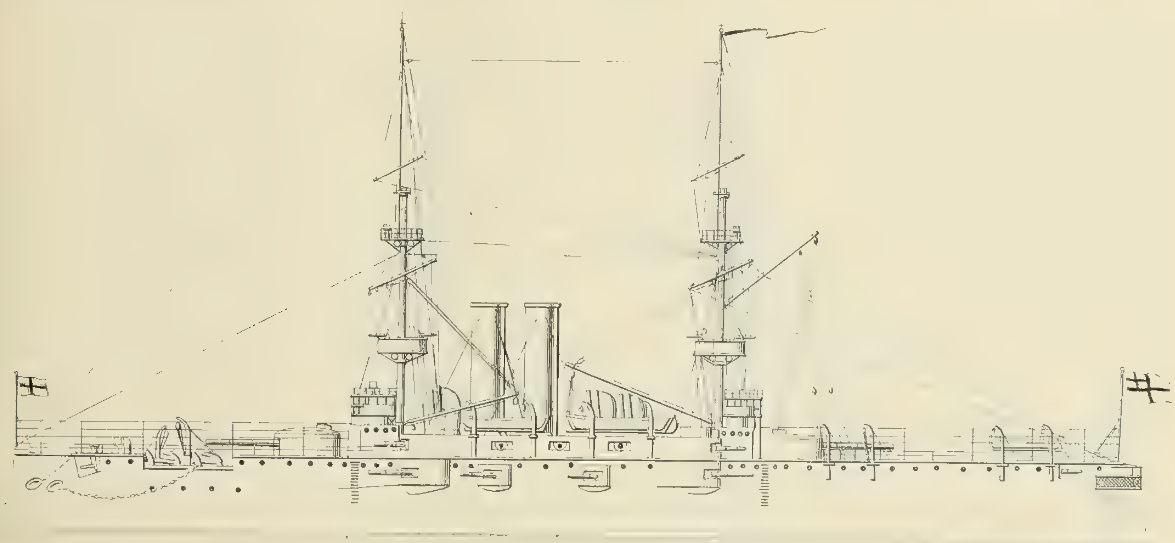


FIG. 1.—H. M. S. OCEAN. BUILT AT DEVENPORT DOCKYARD.

ship just before launching, and this varies with the position decided on for the top of the camber. Dockyard practice in this respect differs, and this point is sometimes at mid length, and in other cases at two-thirds the length of ship from the bow, or even at the after perpendicular. The declivity of 51-64 in. to the foot, referred to above, is the gradient of the tangent to this curved surface at the top of the camber, and the holding tendency is greatest the farther aft the tangent point is. In the *Ocean* this point was at the aft side of stern post or after perpendicular. In launching, the fore end of the straight part of the keel approaches the bottom of the slip in each foot of movement approximately by the difference between the launching and building declivities, viz.,

$$\frac{51}{64} - \frac{5}{8} \text{ or } \frac{11}{64} \text{ in.}$$

and as the distance from the fore end of the keel to the after end of the straight floor of the slip was 348 ft., this drop of the keel was 11-64 in. × 348, or 5 ft. This considlaunching weight to be made. The proper progress of the ship fixed the parts which made up this weight, and thus it was possible to calculate in detail the weight of the several parts, and the positions of their centers of gravity. The weight calculation is much simplified when, as is usual, a record is kept of all weights put on board. The total weight, and the position of center of gravity both vertically and horizontally, were thus obtained, and were easily corrected as the actual date of launch approached, and a closer approximation to the launching weight became possible. The probable height of tide was given by the tide tables, and was drawn upon the profile of the ship as she lay on the blocks (Fig. 3). The displacement was calculated to lines parallel to this at any convenient distance, say 2 ft., which, as the ship was launched at a declivity of 51-64 in. to the foot, corresponded to a travel down the ways of $\frac{2 \times 12 \times 64}{51}$,

or about 30 ft., and this is the distance apart of the cal-

culated ordinates giving the curve of buoyancy (Fig. 2). The position of the center of buoyancy was also estimated for the displacement to each waterline. These calculations assumed that the ship did not lift off the groundways as the after part became immersed, and it is also clear that the trim differed widely from the water-borne condition, because the keel was at a declivity of 5-8 in. to the foot, and in a length of 390 ft. this gave a difference of draft at the fore and after perpendiculars of $5\text{-}8 \times 390\text{-}12$ ft. = say, 20 ft. 4 in.; while the trim by the stern when the vessel was afloat was only 3 ft., and her fully laden condition is designed for an even keel.

The results of these calculations, and the moments of weight and buoyancy about the after end of the ways and the fore poppet, are plotted in Fig. 2, where the abscissæ represent the travel of the ship down the ways. The weight being constant is shown by a straight line parallel to the base. The curve of buoyancy intersects this at a point *A* after the ship has traveled 337 ft., when she is fully water-borne. The center of gravity of the ship was over the after end of the ways when she had moved 277 ft., when, of course, the moment of weight about this point was zero, while there was then a large positive moment of buoyancy, which was maintained and increased relatively to the moment of weight until the ship was fully afloat. There could therefore be no tipping motion while on the ways. Although when the weight of the ship was taken on the cradle, the pressure per square foot on the groundways was not uniform, it only varied with the relatively small variation in the weight of the ship per foot of length as built at time of launching, when generally there is but little local concentration of weight due to such fittings as armor, machinery, etc. As buoyancy is gained in launching, a point is reached when the fore end of the cradle is alone in connection with the groundways, and it is there the local stress in launching is greatest. This is shown in Fig. 2, where the moment of weight about the fore poppet, being constant, is represented by a straight line parallel to the base, and the curve of moment of buoyancy about the same point intersects it at a point *B*, corresponding to a travel of 302 ft. when the stern of the ship commences to lift. The compressive force on the fore poppets at this moment is shown by the difference or ordinate *C D* between the curves of weight and buoyancy, and was equal to 1,320 tons, or 660 tons on each poppet, which had an area of 25 sq. ft., and therefore bore momentarily a stress of 26.4 tons per sq. ft. The mean pressure per square foot of bearing surface of the cradle between the fore and after poppets when in position on the slip differs considerably with different ships, ranging from about one to three tons, which is very seldom exceeded. In this instance it was 2.5 tons.

While it is not generally necessary with warships to determine whether they will have stability in the launching condition, because they are designed to be stable, however light, yet such a calculation is made, and both the vertical position of the center of gravity and the metacentric height are ascertained. The latter in this case was 12 ft. The trim of the ship when afloat was also estimated, and showed that she would not be fully water-borne when the cradle left the end of the groundways, but would drop about 4 ft., for which there was ample depth of water. The details of the structure of groundways and cradle, and the internal shoring of the ship to enable the strains developed in launching to be effectively distributed and safely borne, are worth description.

GROUNDWAYS.

The groundways were 427 ft. long, and 6 ft. 6 in. wide, and were laid on transverse blocks of oak in wake of each "land tie," or wood foundation, of the slip, spaced about 5 ft. 9 in. apart. Between the oak blocks were two of fir, equally spaced for about two-thirds the length of the slip, until near the position of the fore poppet already referred to, where the stern of the ship commences to lift. Below this the blocks were of oak or teak, laid side by side. The upper surface of the blocks was trimmed throughout to the camber, and covered with 5 in. teak plank, secured with 3-4 in. bolts, 9 in. long, rag-pointed, and punched down below the surface at least 3-4 in. to obviate all danger of their protruding under the compression of the ways and obstructing the launch. The butts of these planks were well distributed, and were beveled, as shown in Fig. 8, to facilitate the travel of the cradle over them. The foremost planks in each strake were made as long as possible, doweled into the blocks, and extended well abaft the fore end of the cradle. Through these planks was bolted the large cleat *A* (Fig. 4), which formed a base for the pressure of the hydraulic pumps, provided for pushing the ship off, if necessary. On the outer end of these groundways a "ribband" *A* (Figs. 7 and 9), 12 in. × 10 in., extending the whole length of the ways, was fitted. It was of fir, except the upper 30 ft., which was of best English oak. The general security was 3 1-2 in. wood dowels, about 5 ft. apart, for about 300 ft. down, with intermediate bolts 1 in. in diameter, except at the fore end, where they were 1 1-8 in. The plank of the groundways on which the ribband rested was also doweled to the transverse blocks in wake of the land ties below it, as well as bolted like the other plank. The oak ribband, whose fore end took the thrust of the dogshore, was doweled to the plank, and bolted alternately through it to each transverse block of the groundways, and had a steel shoe at the fore end whose faying surface against the dogshore was planed *B* (Fig. 7). This ribband was laid so that when the cradle was in position there should be a clearance between the two varying from 1-2 in. at the upper to 2 1-4 in. at the lower end of the ways. This provided against the cradle jamming between the ribbands as the ship went off, and the increased clearance at the lower end gave play for some small amount of swerving on the ways if the tide caught the ship before she was fully afloat. To resist the tendency of any such movement to carry away the ribband, each piece was shored not only at the butt, but also in mid-length, the shores being about 10 ft. apart in wake of the cradle and 20 ft. below. To prevent the shores, which are fitted below high water, from lifting under the action of the backwash as the ship went off, they were bolted to the groundways and lashed to the land ties of the slip at their outer ends. The three ribband shores at the fore end of the cradle were only 5 ft. apart. The outer ends

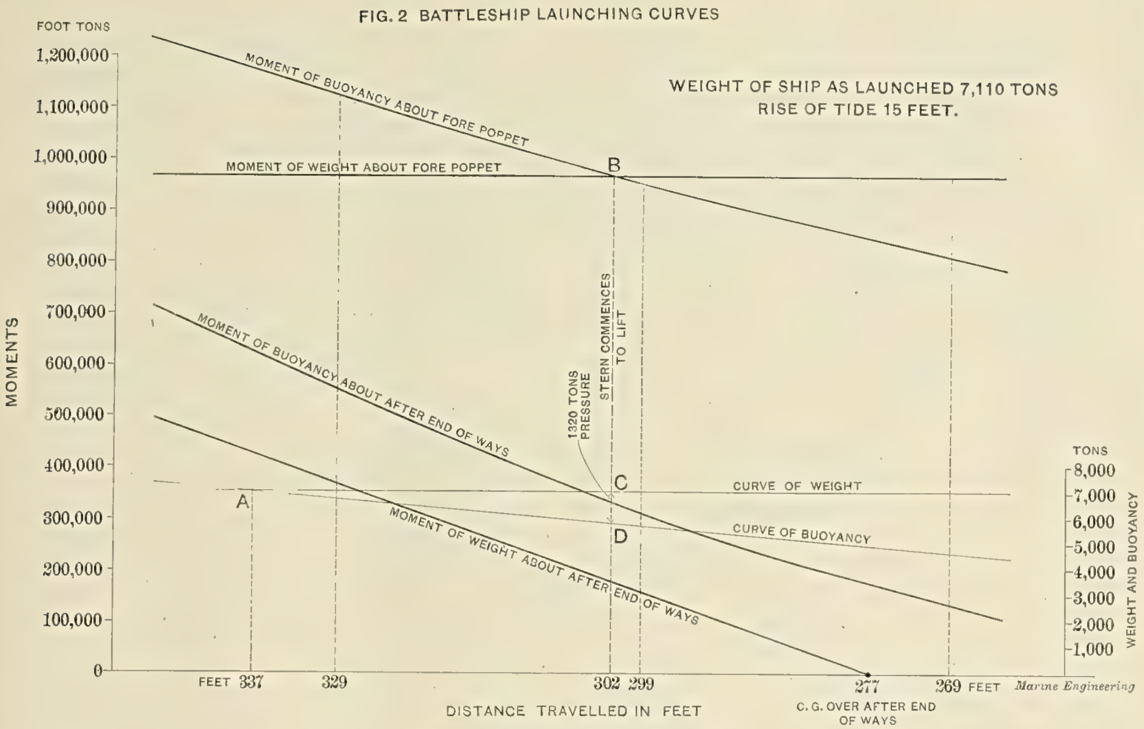
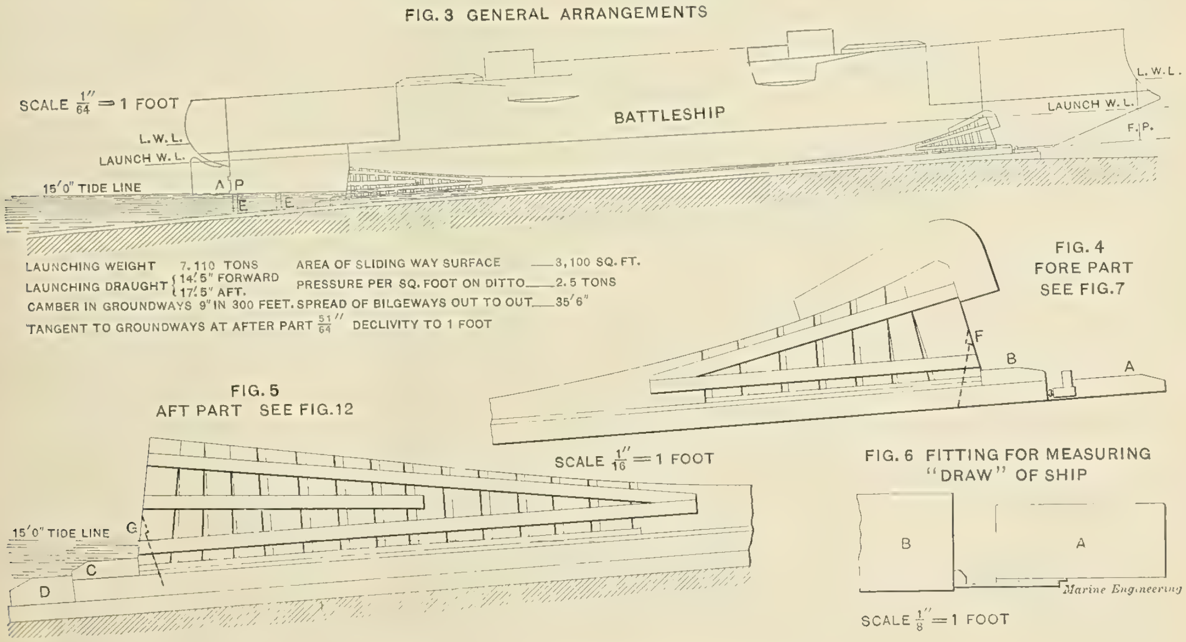


FIG. 2.—BATTLESHIP LAUNCHING.

of all these shores butted against the solid masonry at the sides of the slip.

CRADLE.

The general construction and component parts of the cradle will be understood from Figs. 3 to 18 inclusive. The fore end of it was about 65 ft. abaft the stem, and the after end at the extremity of inner shaft tube, both being in wake of one of the main transverse bulkheads. Resting on the groundways are the bilgeways, solid timber structures of Dantzic fir, 310 ft. long, 5 ft. wide, and 2 ft. thick, the lower surface being faced with 4 in. teak, called the "sliding plank." The fir section of 20 sq. ft. was made up of four balk with plain butts, the several lengths well overlapping and being bolted and doweled together. The teak sliding plank was fastened with 3-4 in. rag-pointed bolts, 8 in. long, the heads being punched below the surface at least 3-4 in., as described for the fastenings of the groundways, and for a similar reason. The ends of the bilgeways were built up by cleats, *B C* (Figs. 4 and 5), and thus formed stops



FIGS. 3, 4, 5 AND 6.—BATTLESHIP LAUNCHING.

for the heels of the end poppets. As the fore end of these bilgeways had to bear considerable stress, the cleat was of English oak the full width of the ways and strongly bolted to them, and on its outer side was fitted the dog-cleat of English oak, 1 ft. square in section, fastened not only with dowels, but with 1 1-4 in. galvanized bolts passing right through the cleat, the heads bearing on a steel face-plate to the dog-cleat 5-8 in. thick, and the points have up on a similar plate, as shown on plan and section through *CD* (Figs. 10 and 11). The after end of this dog-cleat was fitted with a steel shoe *E*, similar to that at the fore end of the riband. The space between these two points was filled by the dogshore of African oak, 10 ft. long and 1 ft. square in section, having a steel shoe at each end *FG*, similar to those it bore against. It was this shore on each side which, with the few blocks remaining under the keel just before launching, and the friction of the grease on the ways, prevented the ship from being launched. Fig. 7 shows that the shore was cut at the fore end to such an angle that it cleared itself as it fell.

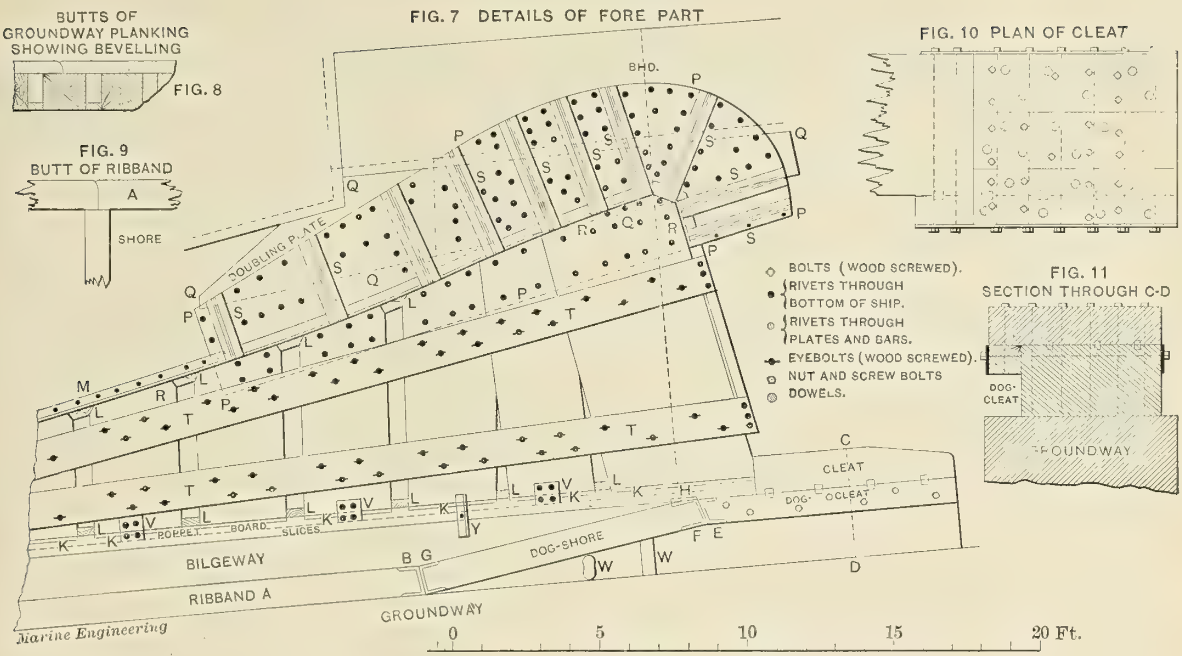
A trial of this is always made when the shore is first fitted, and before any strain comes upon it, by letting a dummy weight fall upon it. The wedge-shaped steel face *H* on top of the dogshore, immediately under the weight, had its upper surface square to the direction of the blow, the full effect of which was thus transmitted to the shore. While the exact resistance to be overcome in knocking away the dogshore cannot be determined, a rough estimate on the safe side may be made by resolving the weight of the ship parallel to the thrust of the shore, and assuming that the blocks remaining under the ship and the grease upon the ways bear no part in resisting this. We thus get a crushing force on each shore of about 240 tons, and taking the coefficient of steel on steel as 0.3, and allowing that the shore clears itself after about 1-2 in. of travel, which is really the case, we get—

Work to be done $= 240 \times 0.3 \times \frac{1}{24} = 3$ ft. tons.

The work due to the fall of half a ton through 17 ft., which was provided for, is 8 1-2 foot-tons, which, with the other assumptions in favor of the pressure to be overcome, gave sufficient margin for safety. The remainder of the cradle above the bilgeways consisted of three parts, the stopping up—amidships—and the fore and after poppets. The stopping up, which, like the poppets, was of the full width of the bilgeways, namely, 5 ft., consisted of solid Dantzic fir timber carefully fitted to the bottom of the ship, and 192 ft. long. The poppets varied from 15 to 25 sq. ft. in sectional area, and were nearly vertical, except the first and last two or three, which stood rather more square to the surface of the bottom in a fore-and-aft direction. The heels of these poppets were steadied by tenons 9 in. wide and 1 1-2 in. deep, which fitted a fore-and-aft groove *KKK* (Figs. 7, 12 and 18), in the 6 in. poppet board of English elm below them; the spread of these poppets at the heel just above this board, and also at the head, was preserved by chocks, *LL*, but the end poppets, especially those forward, were close fitting from the head well down their length. The various pieces composing them were not only bolted together like the others, but were also doweled. Each set of poppets was connected together outside the cradle by steel "dagger" plates, *TT* (Figs. 7, 12 and 16), three aft and two forward, 14 in. wide and 3-4 in. thick, secured to the poppets by Blake's screws, and extending far enough from each end to overlap and be fastened to the stopping up. Between the upper surface of the bilgeways and the underside of the stopping up and poppet board, was a space of 4 1-4 in., in which the "slices" or beech wedges, 6 ft. 6 in. long, were inserted when it was desired to "set up" the ship, *i.e.*, to take the weight on the cradle and off the blocks sufficiently to enable the latter to be rammed out. To prevent the cradle falling outward at the head, a steel angle *M* (Figs. 7 and 12) was riveted to the bottom of the ship, extending from near the fore end to the extreme after end, where it was turned down over the aftermost poppet. The position of the after poppets, and the shape of the bottom there, gave their heads a much better bearing against the ship than was the case forward, and as the after end of the ship was soonest water-borne, and the poppets there were not subject to the great stress of those forward, it was not necessary to do more than support the angle referred to by the bracket plates shown at *NN* (Fig. 12), which in each case were continued as far as the projecting edge *OOO* of the bottom plate above. At the fore end special strengthening was necessary for reasons already stated, and is shown by Fig. 7, where the plate *PPP* was of 1-2 in. steel, with a similar plate, *QQQ*, riveted at the back of it, and fitting closely between the projecting edges of the bottom plates above and below it, thus greatly stiffening the structure to resist shearing of the fastenings. Over the heads of the poppets a 5-8 in. steel plate, *RRR*, riveted to a 7 in. by 3 1-2 in. by 5-8 in. angle bar, was fitted and turned down over the fore end of the foremost poppet, the connection being stiffened by ten brackets, *SSS*, formed of 1-2 in. plates and double steel angle bars. All the parts of this plate and angle structure were most carefully fitted to each other and the bottom, the only connection to the latter by 1 in. steel rivets through the plating between the brackets. The single shearing stress of each rivet is assumed at twenty tons.

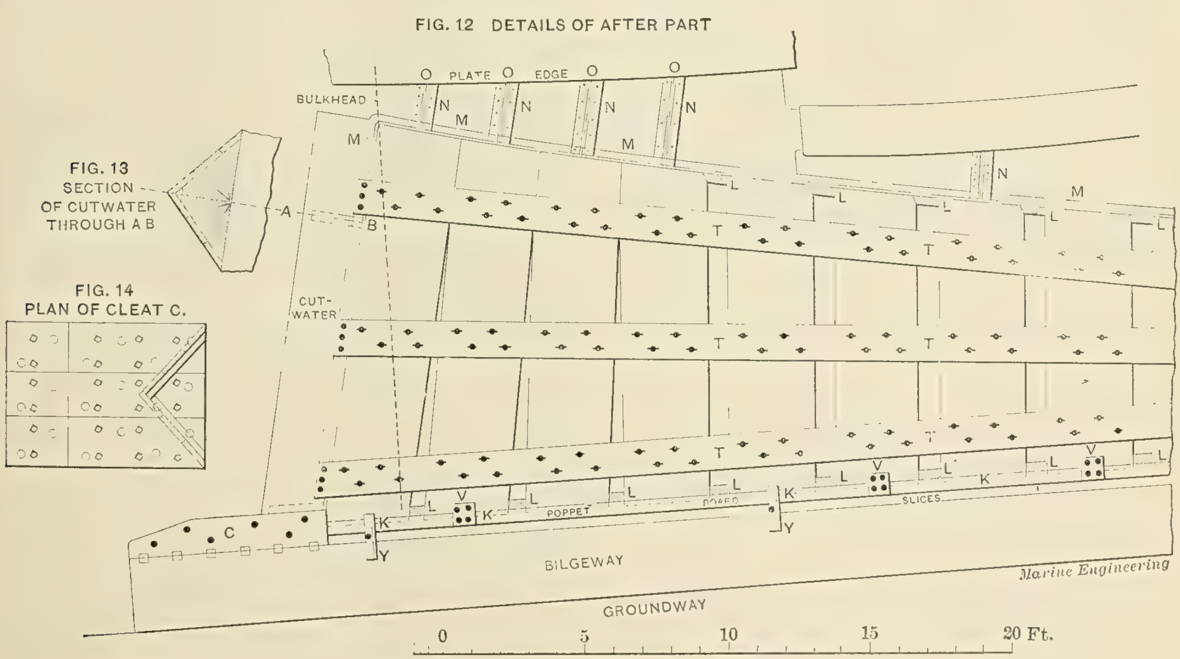
This structure might yield in two ways: (*a*) by the shearing of all the rivets in the brackets and angle bars over the heads of the poppets, or (*b*) by shearing all those through the bottom, and also those through the brackets and doubling plate. The pressure on the fore poppet when the stern began to lift has been given as 660 tons, and this may be resolved into a tangential stress of 585 tons, and one of 320 tons normal to the bottom. Assuming this tangential stress distributed by means of the structure over the area surrounding the heads of the foremost three poppets, we should have to shear about 120 rivets in case (*a*), giving a total shearing stress of $120 \times 20 = 2{,}400$ tons, and a factor of safety $= \frac{2400}{585} = 4.1$, which is ample. Fracture in case (*b*) would need a shearing stress of $167 \times 20 = 3{,}340$ tons, or a factor of safety $= \frac{3340}{585} = 5{\cdot}7$.

In order that the two parts of the cradle should preserve their relative positions during launching, spread shores, about 12 in. square and ten in number, were fitted between them under the keel, and resting in English elm cleats secured to the bilgeways (Figs. 16 and



FIGS. 7, 8, 9, 10 AND 11.—BATTLESHIP LAUNCHING.

17). One of these shores was at each end of the ways, one opposite the fore end of the dogshores, and the remainder divided the intervening length about equally. These acted as struts. Between them at the butts of the stopping up, spread chains were fitted as ties, setting up to 1 3-4 in. steel eye-bolts, through the stopping up, the bolts being hove up on plates covering the butts on the outside of the cradle (Fig. 15). These spread chains were not fitted to the wake of the poppets. No part of the cradle was attached to the bottom of the ship, and as it was fitted below the bilge keel, and had a certain amount of buoyancy, it might leave the ship as soon as she was afloat, and be held under the bilge-keel, unless this were provided against. To keep it clear, T bars or double angles were fitted, as shown by *B* (Fig. 15), at intervals of about 15 ft., tapped to the bottom of the ship and bilge-keel, and having a wood strut *C* above each in the angle formed by the bilge keel and bottom of the ship. The close fitting of the cradle, and the pressure developed in launching, generally make the cradle adhere so firmly that it must be pulled out by tugs, as it is necessary to remove it



FIGS. 12, 13 AND 14.—BATTLESHIP LAUNCHING.

for the safety of the ship in docking. For this purpose steel-wire hawsers were separately attached to the fore and after ends of the cradle, and to each piece of the stopping up, the ends of the hawsers being carried inboard on the upper deck till wanted.

INTERNAL SHORING.

While the fullest use was made of the structure of the ship to prevent any alteration of form under the strains borne in launching, by having all possible pillaring complete, and all bulkheads and flats riveted off, it was necessary to provide some internal wood shoring, as shown in Figs. 15 to 18. The spread of the cradle from out to out was 35 ft. 6 in. (Fig. 16), which caused it to bear directly under one of the longitudinals for a great part of its length (Fig. 15). Short shores were also fitted, as shown between the inner and outer bottoms, above the edges of the cradle, and a covering balk was laid on top of the inner bottom, from which stout shores reached to the protective deck. The great strength of the framing between the inner and outer bottoms for the engine bearers, and that of the bearers themselves, which were complete, made special shoring at that part unnecessary, but for the remaining length of the cradle, and particularly abreast of the foremost poppets, it was provided, and at the latter place the structure was stiffened from one side of the ship to the other (Fig. 18). The total weight of these shores was about 90 tons.

LUBRICATION OF SLIDING SURFACES.

The whole of the work already described was completed a fortnight ago before the launch, when preparations were made for applying the lubricants to the sliding surfaces. For this purpose the whole of the cradle above the bilgeways was temporarily suspended to the bottom, on the outside of the cradle, by strips of 1-2 in. plate, *A* (Figs. 15 and 16), tapped through the bottom of the ship and screwed to the cradle. On the inside, wood struts, *D* (Figs. 15 and 18), 6 in. by 6 in., resting on the bottom of the slip, and screwed below to the groundways and above to the cradle, kept the latter in position against the bottom of the ship. The poppet board was secured to the poppets, both inside and outside the cradle, by plates, *VVV* (Figs. 7 and 12), screwed to both, and left in position until the ship was afloat, which prevented the board from leaving the poppets and sinking, as, being of English elm, it might do. The ribband on the outer edge of the groundways was then removed, and 5 in. plank *E* (Fig. 18), fixed at intervals from 20 ft. to 30 ft, with its inner end at top level with the top of the groundways, and sloping up and outward The bilgeways were next hauled by steam winches on to these supports, and the remainder of the cradle was temporarily shored up from the groundways *F* (Fig. 18).

After a careful inspection of these surfaces, the lubricants were applied first to a short length of the ways, which was coated to the required thickness, and then loaded over a portion of its surface to the mean pressure of 2.5 tons per sq. ft. by ballast, this load being launched, and testing the adhesiveness of the lubricant to the groundways and its adaptability generally for its work. The exact position of the bilgeways having been razed in on the groundways for fitting purposes, wood battens 1-2 in. thick were nailed to these lines, and the space between them coated with Russian tallow applied hot until a solid coating 3-8 in. thick was obtained. It is sometimes an advantage to mix beeswax with the tallow in order to assist the cohesiveness of the lubricant and prevent it from cracking and caking. On this a coating of "slum" was placed, made up of Russian tallow and train oil boiled together and well mixed in the proportion of four gallons of oil to 112 lb. of tallow, being one part oil to two of tallow. This was not applied hot. The proportion of oil varies with the temperature of the atmosphere, being less in hot than in cold weather. The surface of the slum was irregularly grooved, after which train oil was poured upon it, and finally soft soap scattered in patches throughout the length of the cradle. The under surface of the bilgeways was coated with Russian tallow similarly applied, but only to a thickness of about 1-2 in., on which the slum was placed. The side of the ribband next to the bilgeways was also thickly coated with slum, and the narrow space between them sprinkled with oil. Across the surface of the groundways, forty grease irons, *GG* (Fig. 18), to keep the bilgeways clear of the groundways while being hauled back, were then placed in pairs and steadied on the inside of the cradle by workmen, until the bilgeways were hauled again into their proper position, and fayed against the struts previously described as supporting the cradle against the bottom of the ship. The grease irons were withdrawn, the battens removed, and the long beech slices, of which about 1,300 were used, were inserted between the bilgeways and upper part of the cradle, except those below high water, which were not put in until it was necessary to drive them, and so were kept dry. The temporary struts and angle supports to the cradle were next removed, the ribband on the outer edge of the groundways were replaced, fastened, and shored, the holes through the bottom of the ship were plugged, and the cleats on the bilgeways replaced and bolted. A large cleat, *D* (Fig. 5), was also bolted to the groundways at the lower end of the cradle to prevent any premature sliding movement. Ten steel keys, *E* (Fig. 15), on each side, varying regularly from 1-2 in. to 1 3-4 in. in thickness, from fore to after end of bilgeways, were then inserted at equal distances between them and the ribband, and maintained them in position. Battens *F* were nailed over this groove to prevent any substance getting in which might obstruct the launch. The remaining slices were inserted, the dogshores were placed, and two "triggers," *WW* (Fig. 7), put beneath each, that with a plain beveled end preventing the shore from falling, and the other with rounded end serving the same purpose when just before launching the former was removed. Between the slices at intervals were twelve steel angles *YY* (Figs. 7 and 12), on each side of the cradle, connected by bolts hove up with nuts, and these helped to keep the sides of the cradle in position and flush with those of the bilgeways.

SETTING UP THE SHIP.

Preparations were then made for "setting up" the ship. This operation is generally begun the day before the launch, the after portion only being dealt with at that time, say, for about one-fourth the length of the cradle. For this purpose the slices were manned both inside and outside the cradle by shipwrights with heavy

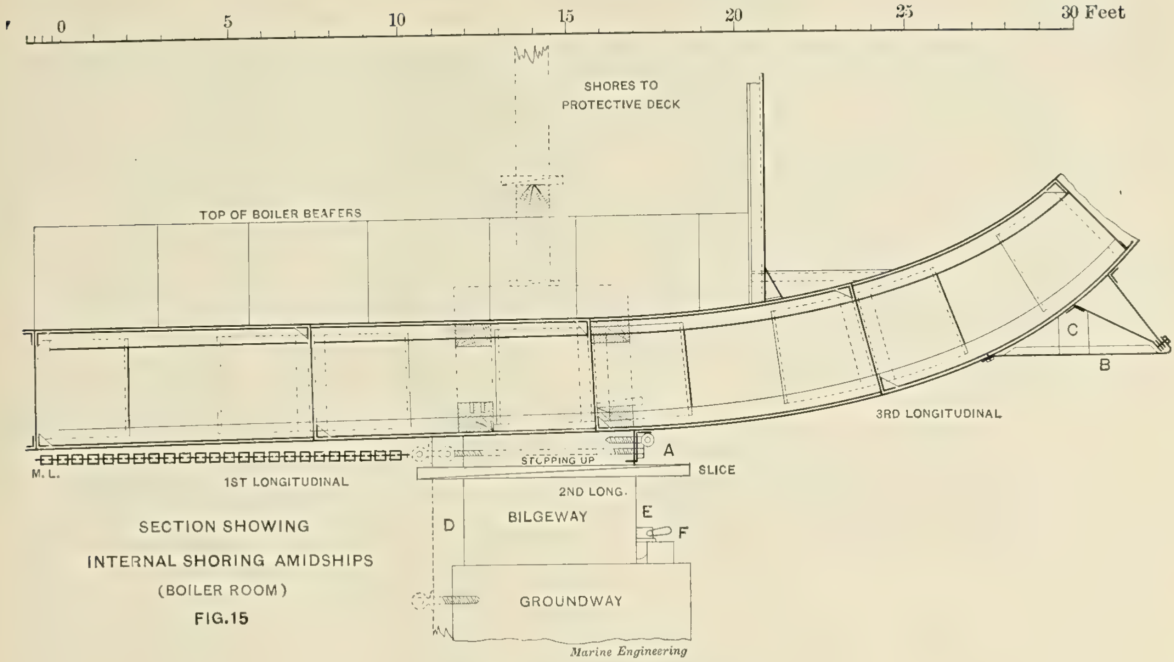


FIG. 15.—BATTLESHIP LAUNCHING.

mauls. The shores at this part were also manned and kept effective as the setting up proceeded by tightening the wedges under them. At a given signal the whole of the men struck together. The strain on the building blocks was tested at intervals by striking the wood wedge blocks, *HH* (Fig. 18), of each tier until it was clear that they had been relieved sufficiently to enable them to be readily removed. This removal followed immediately upon the conclusion of the setting up, and the building shores under the bottom inside the cradle were also taken away, the remaining shores outside the cradle being roped at the head and the ropes carried inboard in readiness for lowering them on the launching day after completing the setting up. As the blocks were removed, "skeg" shores, *EE* (Fig. 3), rounded at each end, were placed under the keel at intervals to assist in supporting the overhanging part of the ship beyond the cradle and the blocks left standing. These shores are generally left in position until the ship is launched, the form of their ends making it easy for her to trip them as she moves. The drying and lubrication of the ways below the cradle was carried out on the morning of the day of launch as the tide ebbed, and finished as it rose. The completion of the setting up commenced at about the same time, and somewhat abaft where it was left the day before, and was continued until near the fore end of the cradle. It is not usual to set up the extreme forward end, but only to tighten up the slices there as necessary to give them a proper bearing. Three or even four slices were allotted to each man in setting up. When this work was finished the heads of the slices were roped together, as they have some buoyancy and might otherwise float away singly when the ship was launched. The remaining shores between the cradle were removed, and the dogshores were tightly set by driving a thin steel wedge between them and the fore end of the ribband on the groundways. Additional security was given to the foremost and aftermost poppets

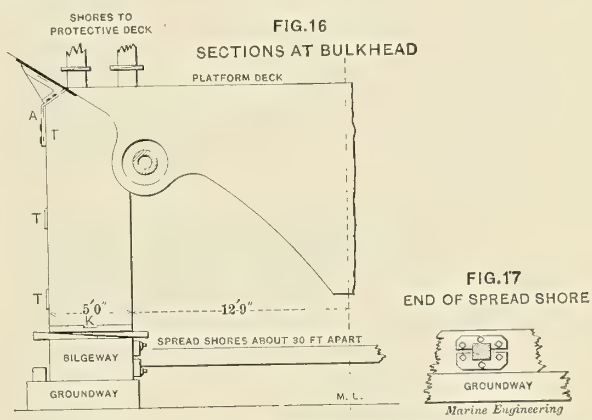


FIG. 16 AND 17.—BATTLESHIP LAUNCHING.

by driving two long bolts through each into the bilgeways *F* (Fig. 4) and *G* (Fig. 5), and to somewhat lessen

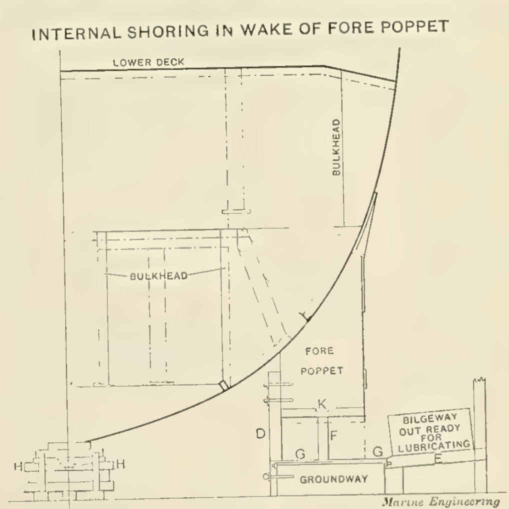


FIG. 18.—BATTLESHIP LAUNCHING.

the resistance a cut-water was fitted against the aftermost poppet. The remaining building shores were then knocked away, commencing from forward and working regularly aft, as the foremost shores tend to push the ship down the slip, while the after ones act as struts against this.

The completion of the setting up was effected in time to enable all these shores to be got away before the rising tide reached the aftermost. It frequently happens that as the remaining keel blocks are removed, and the ship settles down on the cradle, she moves slightly or "draws," and before knocking away these blocks means are adopted for measuring this movement by fixing two battens parallel to but not in contact with each other, one to the fore end of the sliding ways, and the other to the side of the fixed cleat at the fore end of the groundways, and with their upper edges in the same plane. Across the edge a line is transversely drawn, and whatever slight sliding motion takes place is shown by the distance between this line on the fixed and the moving batten (Fig. 6). A corresponding "tell-tale" was also fitted to the stem of the ship upon the launching platform. The difficulty of getting the keel blocks away varies greatly with different tiers, depending partly upon unequal crushing of the blocks during building, and the extent to which the ship is set up and afterward settles upon the cradle and blocks. Generally the excessive pressure is only upon a few tiers of blocks, and, as the hour of launching draws near, may be only upon one tier. As a rule, upon the day of launching, the blocks are only removed sufficiently in advance of the tide to permit the work to be done. This remark applies also to the removal of the bilge cleat at the after end of the bilgeways, and to that of the steel keys and battens on top of the ribband. Should the ship be lively and draw to any extent, some tiers of blocks would be replaced and the ship would be allowed to trip them in launching. If, however, the tell-tales show no sign of movement in the ship, the removal of the blocks would proceed right up to the time of launching, and it might even happen that no blocks would remain under the keel when the dogshore fell, but this extreme is not usual. Experience must guide in this matter in connection with the circufmstances of each case, and ships of the size now described have been launched with as many as nine-and-twenty tiers of blocks standing, and with as few as one. The removal of the blocks is facilitated by the method of building them; the wedge blocks *H* (Fig. 18), generally soon yield to the blows of a ram, but in addition to this, the thin top or "cap" block is usually of some straight-grained but fairly hard wood, such as teak, which has to be split out by steel wedges when the ram fails. The use of gunpowder for this purpose has been known in a private shipbuilding yard.

HOGGING AND SAGGING.

After the ship was set up, means were taken to ascertain how much the elasticity of the structure allowed her to alter form, both longitudinally and athwart-ships, from the land-borne to the water-borne condition. As great a length as possible on the upper deck was chosen, and three vertically adjustable sight battens were carefully fixed, one toward each end and one about amidships, the edges of the battens were carefully sighted, so as to be in one plane, and the positions were marked upon the fixed framework carrying the sights. Similar adjustments were made after launching, and the differences afforded a measure of the droop of the ends of the ship relatively to the middle, or *vice versa*, known as hogging and sagging respectively. Athwart-ship observations of this kind are only made in the ships of greatest beam, and seldom show an appreciable movement. In the case of the *Ocean*, the "breakage" by hogging in a length of 312 ft. was only 5-16 in., and in a breadth of 61 ft., nil.

FREEING DOGSHORES.

Each weight of 1,120 lb. for freeing the dogshore was placed in position on the day of the launch at the top of a shoot which allowed a drop of 17 ft. The weights had been suspended for ten days previously by the white manila rope to be severed at the moment of launch, so that the rope had been fully stretched before the weight was finally put into position. This rope was led over a sheave at the top of the shoot to the front of the ship's ram, and lashed across a wood chock there. The framework of the shoot, consisting of steel angles at the corners, and so having open sides, admitted readily of the insertion of a shore to take the strain of the weight off the rope until the last moment. A tide gauge was fixed at the after end of the groundways, and the height of water over the groundways was recorded in sight of the launching platform every quarter of an hour during the last hour and a half before launching. The number of the blocks remaining under the keel was similarly recorded as each tier was removed. It is not often that the blow of the weight fails to free the dogshore and release the ship, but in case of failure men are ready to cut away this shore with axes, until its weakened section causes it to yield. This operation is dangerous not only to the men, but may be so to the safety of the ship if one shore yields before the other. To assist the ship to start on the fall of the dogshore, a hydraulic pump of 150 tons pressure was placed on each side at the fore end of the bilgeways, and one of 80 tons in reserve. There was also one of 500 tons directly beneath the stem, to ease her off the groundways. Special care was taken to test the efficiency of these pumps, both before and on the day of the launch, and also to see that they were not exerting any pressure until the dogshores had actually fallen.

WATER-TIGHT COMPARTMENTS.

As the work of building progressed, all compartments below the calculated launching draft of the ship, and as many more as possible, had been completed and tested for water-tightness, and the permanent doors or other means of access were also in place and closed before launching. All Kingston valves, sea-suctions to pumps, inlets and discharges through the bottom, were tested and certified to be tightly closed. Two 9 in. Downton's pumps were completely fitted on board to give some power of ridding the ship of water if necessary, and the sluice valves on bulkheads, and water-courses to the pump suctions were all seen to be clear. Men were launched in the ship to make an inspection of all compartments below water as soon as she was afloat, and report the result.

THE LAUNCH.

All being thus in readiness, the tide gauge showing sufficient water, and the harbor reported clear, the men removing the blocks were withdrawn, the shores supporting the weights were taken out, the triggers beneath the dogshores were removed, and the rope holding the weights was severed, knocking away the dogshore, which, together with the weight, was pulled clear of the ways, and the ship was free. No observation of the launching velocity was made, but as a series of such records for various ships launched on the same groundways with different building declivities and launching weights would furnish useful information, it may be possible at some future time to supplement the present paper by a discussion of such particulars. The speed in launching is checked in many private yards by heavy anchors bedded in the ground, and with lengths of cable ranged alongside the groundways, the ultimate tautening of the cable checking the ship. This is suitable and necessary where the ship is launched into a channel of comparatively small extent relatively to her length, and the distance she would travel if free; but the ordinary means of dropping anchor are adopted in the Government yards where the channel is ample enough for the ship to go well out and swing up into the tide when the cable is slipped. If possible, the wood cradle is pulled out before berthing the ship, but generally this is done more at leisure on days subsequent to the launch and before docking.

Eastern Shipbuilding Co.—Another addition to the shipbuilding facilities of the country is shortly to be made by the establishment of a large ship and engine plant on the Thames river at Groton, opposite New London, on the Connecticut shore of Long Island Sound. The promoters of this new enterprise have taken out incorporation papers under the name of the Eastern Shipbuilding Co. Charles R. Hanscom, late general superintendent of the Bath Iron Works, is the president and general manager of the new company and John Sherman Hoyt, of New York, is the treasurer. William A. Fairburn will act as assistant to the general manager, with duties as naval architect and engineer. Mr. Fairburn has been associated with Mr. Hanscom for a number of years, and until recently at the Bath Iron Works. Among those who are understood to be financially interested in the new corporation are C. W. Morse, of New York, and James J. Hill, of St. Paul, Minnesota. The site already selected for the location of the yard consists of a tract of about 30 acres, formerly held by the N. Y., N. H. & H. R. R. Co., and it has a splendid water frontage within a mile of the mouth of the Thames river. Contracts have already been signed for the construction of three large buildings: The plate shop will be 250 ft. by 80 ft.; the bending floor and furnaces 170 ft. by 60 ft.; and the mold loft and joiner shop 250 ft. by 70 ft. A contract for the construction of two freight and passenger steamships of the largest size has been made between the company and James J. Hill as president of the Great Northern Railroad. These vessels, in respect to tonnage, displacement and deadweight capacity, will be the largest in the world. The dimensions will be about: Length, 650 ft.; beam, 73 ft.; depth, 56 ft.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—I.

BY CECIL H. PEABODY.

The principles of the action of the instrument called the planimeter, so commonly used to measure the areas of irregular figures, like steam engine diagrams, are commonly set forth in so mathematical a form as to be unattractive to many readers; consequently, it is thought that a brief description of various forms of this instrument, together with a simple and yet complete discussion of its principle, may be of some interest.

Fig. 1 represents a simple form of the Amsler planimeter, much used for measuring indicator diagrams.

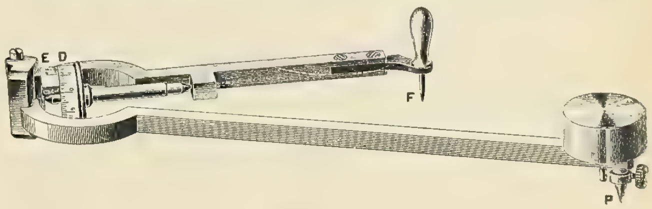


FIG. 1.

It consists of three essential parts, namely: (1) a guiding-arm pivoted at P to the paper, (2) a tracting-arm, which is hinged to the guiding-arm and which carries the tracing point F; (3) a measuring-wheel D which carries a graduated cylindrical scale. There is also an index and vernier for reading the scale on the wheel. When in use the planimeter rests on the paper at three points, the pivot P which is a needle-point

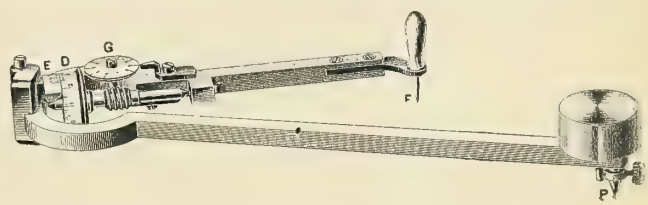


FIG. 2.

thrust into the paper, the edge of the wheel D and the tracing-point F. A weight over the pivot P holds the needle-point down and gives the instrument stability. The instrument is made of German silver and the scale is graduated on celluloid, which makes it easily legible.

Fig. 2 shows the same instrument with the addition of a wheel G to count the number of turns of the measuring wheel.

A somewhat more complicated form with an adjustable tracing-arm is shown by Fig. 3; the measur-

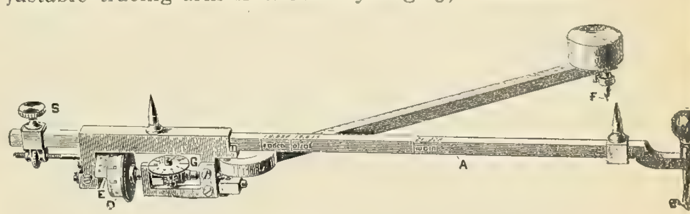


FIG. 3.

ing-wheel D and the recording-wheel G are on a prolongation of the tracing-arm beyond the hinge.

The instruments shown by Figs. 1 and 2 measure

areas in square inches, one entire revolution of the measuring-wheel recording ten square inches; the area may be read to hundredths of a square inch by aid of the vernier. The instrument shown by Fig. 3 may be set to measure areas in square inches, and also in square feet and square centimeters. The points on the back of the tracing-arm are used to set the instrument for convenient determination of mean effective pressure by a method to be described later.

To measure the area of a figure, like an indicator diagram, the instrument is placed as in Fig. 4 so that the arms shall not take inconvenient positions when the outline of the diagram is traced. Make a needle-prick on the perimeter as at the point *F;* place the tracing-point at this needle-prick and set the measuring-wheel to read zero; trace the outline of the diagram in right-handed direction as shown by the arrow; the reading of the wheel will give the area in square inches. The figure represents the planimeter shown by Fig. 3, but the simpler forms are used in exactly the same way. The adjustable tracing-arm of Fig. 3 is supposed to be set to measure areas in square inches.

It is important that the surface on which the measuring-wheel bears shall be flat and smooth, and free

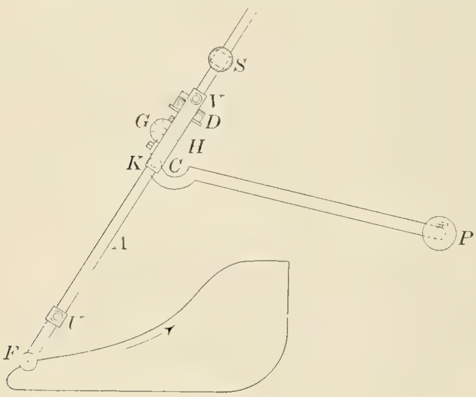


FIG. 4.

from both glaze and roughness. Cardboard or smooth, unglazed paper will answer. If the diagram, for example an indicator diagram, is on a small piece of paper, it is to be pinned securely and the measuring-wheel must not run onto this paper, as its reading will be affected by running over its edge.

For simplicity of statement, the direction was given above to set the measuring-wheel at zero at the beginning of the process of tracing the diagram. In practice it is convenient and customary to omit setting the wheel at zero, taking instead the reading the wheel may happen to have for the initial reading; the reading after the figure has been traced is the final reading; the difference between the initial and final readings gives the area of the diagram.

It is very important that the tracing-point shall be returned exactly to the starting point; a slight deviation may make a considerable error. It is also important that the perimeter of the figure should be followed exactly; some practice is required to gain accuracy and facility. It is well to retrace the figure without deranging the instrument; the difference between the third reading and the first reading is double the area of the figure.

To get a conception of the way in which a planimeter measures an area, we may consider the tracing-arm, with the measuring-wheel, to be separated from the guiding-arm and placed at one side, *hp*, of the rectangle, *hpgi*. Fig. 5. Suppose that the arm is moved

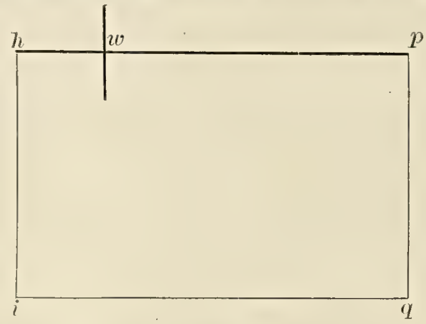


FIG. 5.

parallel to itself across the rectangle *h* remaining on the line *hi;* the wheel will roll without sliding a distance equal to the width of the diagram. Suppose that the arm is 4 in. long from the axis of the hinge to the center of the tracing style or to the tracing-point; suppose, further, that the circumference of the wheel is 2.5 in. (the diameter is then 0.7957 of an inch). If the wheel makes one turn in crossing the figure it will roll 2.5 in., the width of the figure. The area of the rectangle is $4 \times 2.5 = 10$ sq. in. The scale on the wheel can be divided into ten parts, each one of which corresponds to a square inch. The subdivisions of the scale and the vernier allow us to read to hundredths of a square inch.

It may be worth while to interrupt the discussion long enough to see how the vernier is made and read. Let Fig. 6 represent a scale of units numbered *1, 2, 3,* etc., which are subdivided into tenths. The vernier *ab* is as long as nine of the subdivisions and is divided into ten parts, so that the intervals of the vernier are 9-10ths as long as the intervals of the scale; or in other words they are 1-10 of an interval shorter. The index of the vernier reads *1.7* on the scale, and by estimation about half a subdivision more. It will be noted that the 5th division of the vernier coincides with *a* division of the scale; the 4th division of the vernier is 1-10th of an interval from the next mark on the scale, the 3d is 2-10ths, the 2d is 3-10ths, the 1st is 4-10ths, and the index is 5-10ths of an interval from the mark on the scale. Consequently the reading of the vernier is *1.75*. If the measuring-wheel is divided into ten parts, each of which corresponds to a square

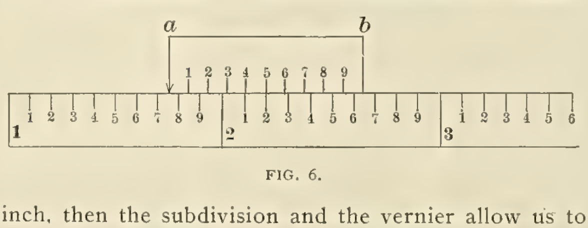


FIG. 6.

inch, then the subdivision and the vernier allow us to read to hundredths of a square inch, as already pointed out.

Returning to the action of the planimeter, consider that the parallelogram Fig. 7 can be measured by moving the arm over it parallel to the side *hp*, keeping the hinge *h* on the line *hi*. During this operation the

measuring-wheel will roll and slide from w to x; the two motions may be analyzed by drawing xy perpendicular to hp, whereupon it will appear that the wheel rolls the distance xy and slides the distance wy. The planimeter records an area equal to $hp \times xy$, which is

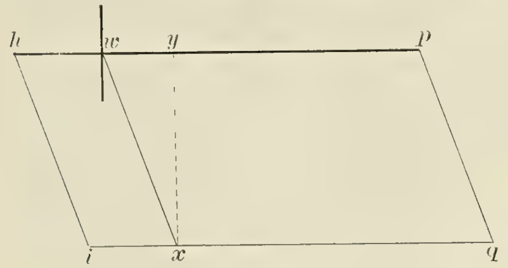


FIG. 7.

equal to the area of the parallelogram under consideration.

The diagram represented by Fig. 8 can in like manner be measured by moving the arm hp parallel to itself with h on the arc hi, during which operation the wheel will roll the perpendicular distance xy. It will be noted that the diagram $hpgi$ may be transformed into the rectangle $hprk$ by transferring the half circular segment rpq to khi.

We are now ready to see how the planimeter can be made to measure the area of a chosen diagram like $pqrs$ of Fig. 9, and afterwards we will see how the method can be extended to any diagram. This figure is described by first moving the tracing-arm parallel to itself from hp to iq, the hinge h being guided on the arc hi by the guiding-arm hg, during which operation the wheel records the area of the diagram $hpgi$; then by swinging the arm from iq to ir, during which the wheel rolls over the arc xy; then by moving the arm parallel to itself from ir to hs, during which the wheel records the area of $hsri$, but since the arm is now moved backward the area is subtraced by the wheel which rolls backward; the diagram is completed by swinging the arm from hs to hp, during which the wheel rolls backward over the arc zw. The angles phs and qir are equal, consequently the arcs xy and zw are equal, and the effect of rolling zw backward counteracts the effect of rolling xy forward, so that the final reading of the wheel gives the difference between the areas of $hpqi$ and $hsri$, provided, of course, that the wheel reads zero to begin with. But the diagram $pqrs$ may be obtained

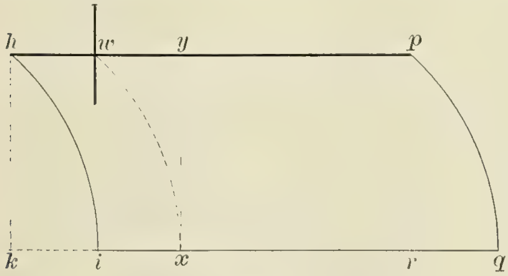


FIG. 8.

by adding $hpqi$ and qiv and substracting $hsri$ and phs, of which qir and phs are equal; so the area of the diagram $pgrs$ is equal to the area $hpgi$ minus the area $hsri$; that is the reading if the wheel is equal to the area of the diagram traced by the tracing-point.

An irregular figure like an indicator diagram may be replaced by an aggregation of figures like $pqrs$, as in Fig. 10, which shall have approximately the same area as the diagram. Each of these figures can be measured separately by tracing its contour with a planimeter, and their areas can be summed up; or the irregular contour of the aggregation may be traced in one operation omitting lines like rq, which are common to two adjacent figures since such lines are traced once in one direction and again in the contrary direction when the figures are traced separately. In Fig. 10 the approximation to the true area of the indicator

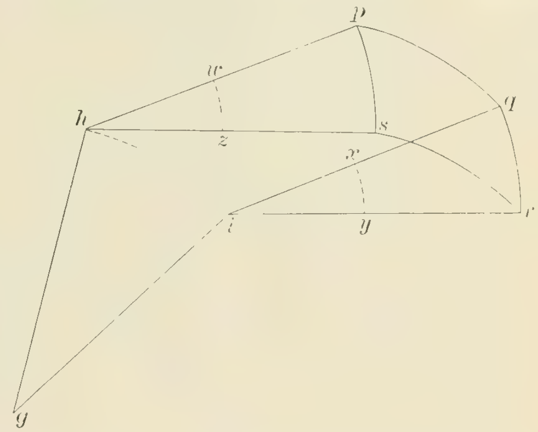


FIG. 9.

diagram may not be satisfactory, because there are only a few large figures like $pqrs$, but by taking enough figures the approximation can be made as close as we please; we may, therefore, conclude that the true area of the diagram will be recorded by a planimeter when

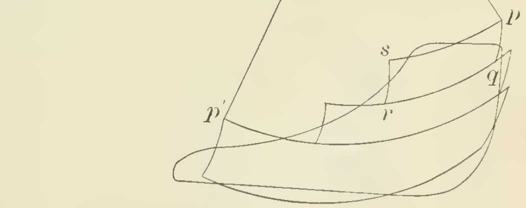


FIG. 10.

the real contour of the diagram is traced, during which operation the tracing arm will have a continuous combined forward (or backward) swinging motion.

The planimeters shown by Figs. 1 and 2 have the tracing-arm 4 in. long and the circumference of the wheel is 2 1-2 in.; one complete turn of the wheel corresponds to 10 sq. in. of area. The main divisions of the wheel (ten for the complete scale) are therefore read as square inches; or the number of revolutions of the wheel (and fractions or decimals of a revolution) may be multiplied by ten to get the area in square inches.

HUGE STEEL FLOATING DOCK AT THE YARD OF BLOHM & VOSS, HAMBURG.

In the accompanying reproduction of a photograph taken recently at the shipyard of Blohm & Voss, Hamburg, Germany, the largest floating dry dock yet completed is shown, with the freight and passenger steamship *Pretoria*, of the Hamburg-American line, 12,500 tons, on the blocks. The capacity of this dock is 17,500 tons, only 500 tons less than the maximum capacity of the new United States floating dock for Algiers, La., now under construction at Sparrow's Point, Md., and which was described in detail in our February issue.

The dock at Hamburg is also built of steel, and is 670 ft. long and 119 ft. 9 in. broad. It consists of seven separate pontoons connected by the high side walls in a single system. The pontoons are arranged so that any of them can be detached for repairs or docked on the dock itself for cleaning. For lifting very heavy, short war vessels of greater weight than the capacity of the pontoons directly underneath, the side walls act as longitudinal girders to transmit part of the lifting capacity of the pontoons not loaded to those which are loaded. It is believed by the designers that in this way the lifting power of the dock is used to better advantage than if each pontoon were made large enough to allow of its receiving the maximum load direct.

There are twenty-one watertight compartments in the dock all fitted with inlet and outlet valves (56 in all), so that any desired change of trim can be readily effected. In each side wall there is an engine room which contains a boiler, built for 180 lb. working pressure, and a set of triple expansion engines. These engines are connected to fourteen centrifugal pumps, of large capacity, for emptying the dock. These rooms also contain generating sets for supplying the electric lights with current, and pressure pumps for operating a hydraulic system for handling the valves. These valves are connected with one central station, in one of the side walls, where the handling gear is located. Water gauges connected with each of the twenty-one watertight compartments are fitted in this room, so that the engineer can see at a glance the condition of each compartment. By a suitable arrangement of levers of the hydraulic gear operating the valves he can regulate the inflow or outflow of water to any or all the compartments, and thus lift or lower the dock as required. This operating room is conveniently fitted up and lighted, so that no matter what the conditions of weather outside—in a snow storm, during rainy weather or on the darkest night—the engineer can attend to his duties in comfort.

During docking, the vessel rests on keel blocks along the middle line, and also on a row of bilge blocks arranged on the ways on either side. By a system of chains and winches situated on the side walls the bilge blocks can be moved transversely or in a fore and aft direction. This dock can be worked with great rapidity —startlingly so to those accustomed to the ordinary dry dock. It is capable of lifting the largest vessel dry in about 45 minutes, and to float the vessel again requires only about 15 minutes.

For warping purposes and taking up the anchor chains of the dock eight capstans are provided on the side walls.

It is the intention of the owners eventually to move the dock to the lower Elbe or Cuxhaven, so that large vessels can be taken on there for cleaning. In case a damaged vessel arrives for repairs, it will be docked there, and then the dock will be towed up the Elbe to the owner's yard where repairs will be effected. Unloaded the draft is about 5 ft., while with the maximum load the draft is slightly in excess of 13 ft., so that the dock with a damaged vessel on the blocks can be towed in shoal water.

This dock was constructed by the owners who also built the two transatlantic liners shown in the photograph. They are both of the intermediate type, in the service of the Hamburg-American line, New York, via Plymouth, to Hamburg. In general dimensions these vessels are practically duplicates. They are: Length, 560 ft.; beam, 62 ft.; depth, 41 ft. They are fitted with twin screws driven by quadruple expansion engines, with cylinders 23 in., 33 in., 48 in. and 69 in. dia. by 54 in. stroke. The gross tonnage is about 12,500 tons. The *Pretoria*, shown on the dock, was turned out in 1897 and the *Graf Waldersee*, lying alongside the wharf, two years later.

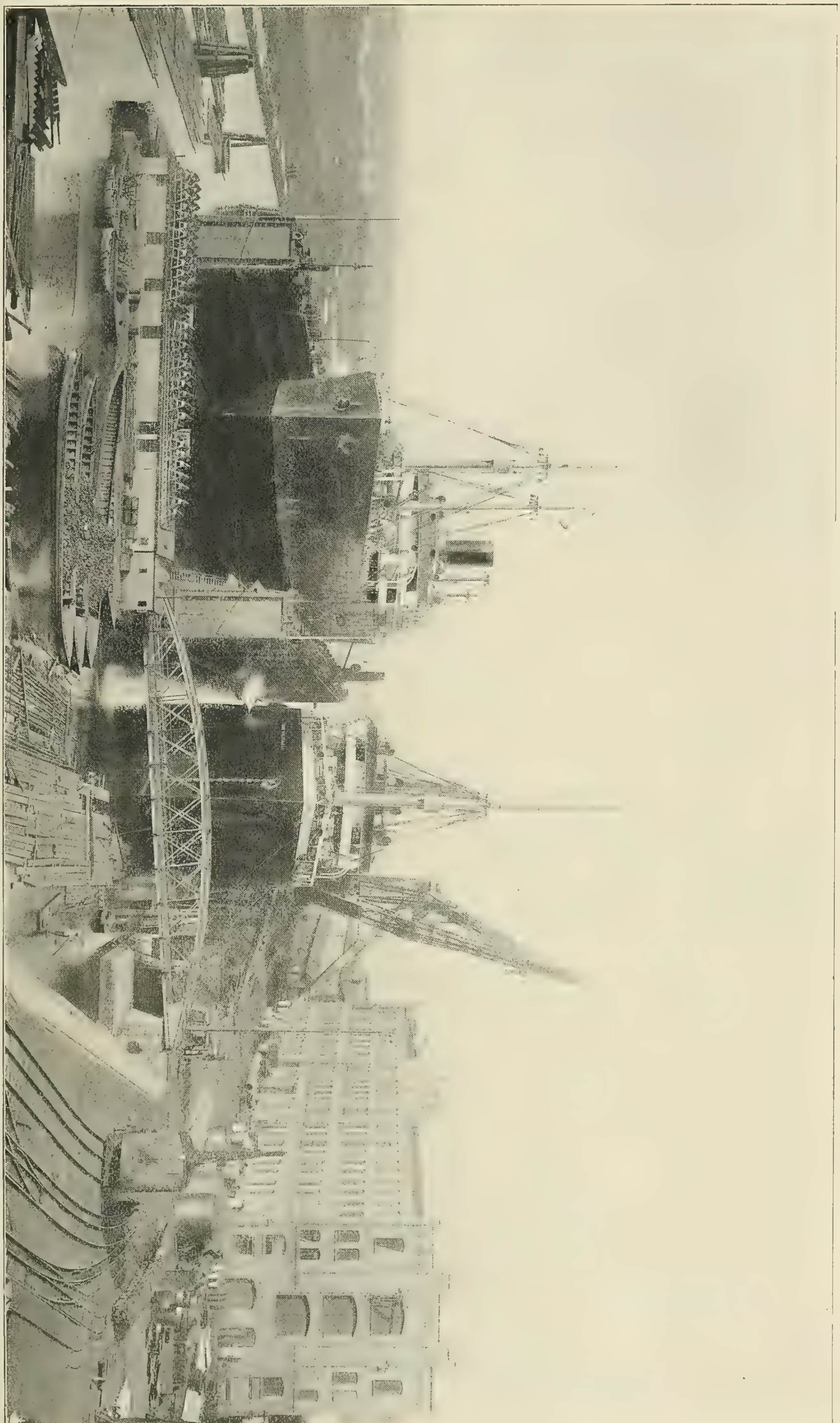
Gasoline Yacht Lady Francis.

In power-driven pleasure craft there is a noticeable increase in the number of vessels fitted with internal combustion engines, which are of larger dimensions that the usual open launch. Nowadays the use of this form of motor is not infrequent in twin screw vessels which in size and general appearance rank with small steam yachts. A vessel of this type recently completed for a Boston owner is the *Lady Francis*, illustrated in the accompanying drawings and photographs.

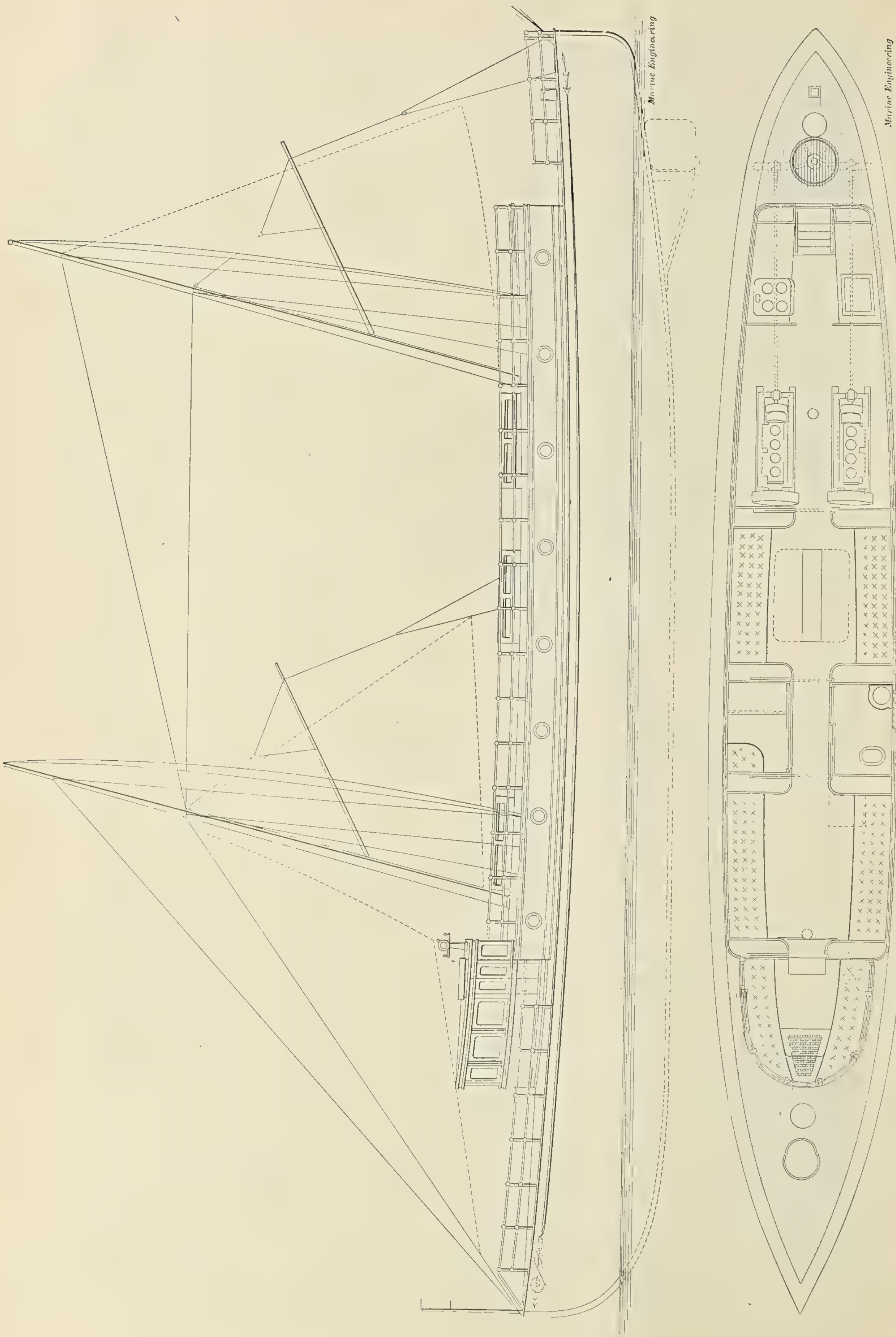
This vessel is 70 ft. long over all, 11 ft. beam, and 4 ft. 2 in. draft, with a gross tonnage of 30.16 tons, and net tonnage of 20.5 tons. She is fitted with twin screws, driven by independent gasoline engines, each developing 30 brake horse power. In design the vessel is intended for service along the Atlantic coast. She has a full bow, easy running lines, with the greatest beam well aft, and a stern of the modified torpedo boat type, thus increasing the water line length and eliminating the tendency to yaw in a following sea. White oak is the material used for the frames, and cedar for the planking, which is double. The under diagonal course is 3-8 in. thick, and the outer fore and aft course is 1 in. thick, with a layer of canvas prepared in beeswax and oil between. Copper fastening is used throughout, and all planking is riveted to the frames over copper burrs. There are two masts, rigged for fore and aft canvas.

Special attention has been given to the accommodations, the various rooms being handsomely finished and decorated. The main cabin is of solid mahogany inside and out, and is conveniently fitted with closets and lockers. In the forward saloon a stationary desk and bookcase are fitted, and there are large plate mirrors in the doors. On top of the deck house there is an extensive promenade for a boat of this size. Accommodations for a crew of four men are provided. The forecastle is fitted with folding bunks to accommodate three, and in the lazarette two men can be berthed if need be.

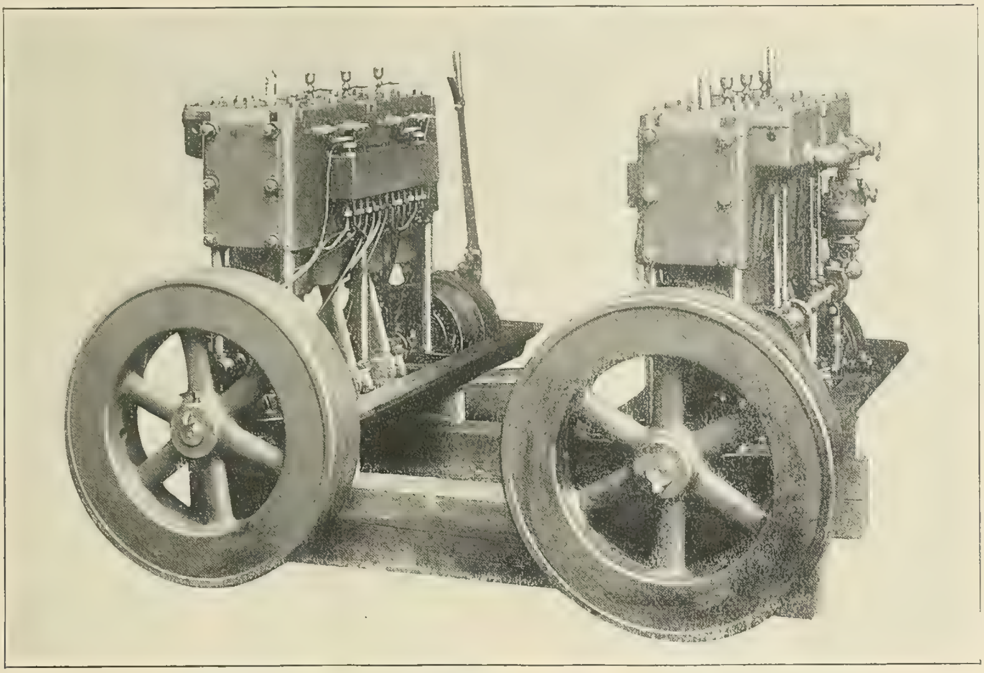
Plumbing work has been carried out with special care. There are four lavatories and three Sands water closets fitted, and a bathtub with hot and cold water



STEEL FLOATING DOCK OF 17,500 TONS CAPACITY AT SHIPYARD OF BLOHM & VOSS, HAMBURG, GERMANY.—S. S. PRETORIA, 12,500 GROSS TONS, ON THE DOCK.—SEE PAGE 150.



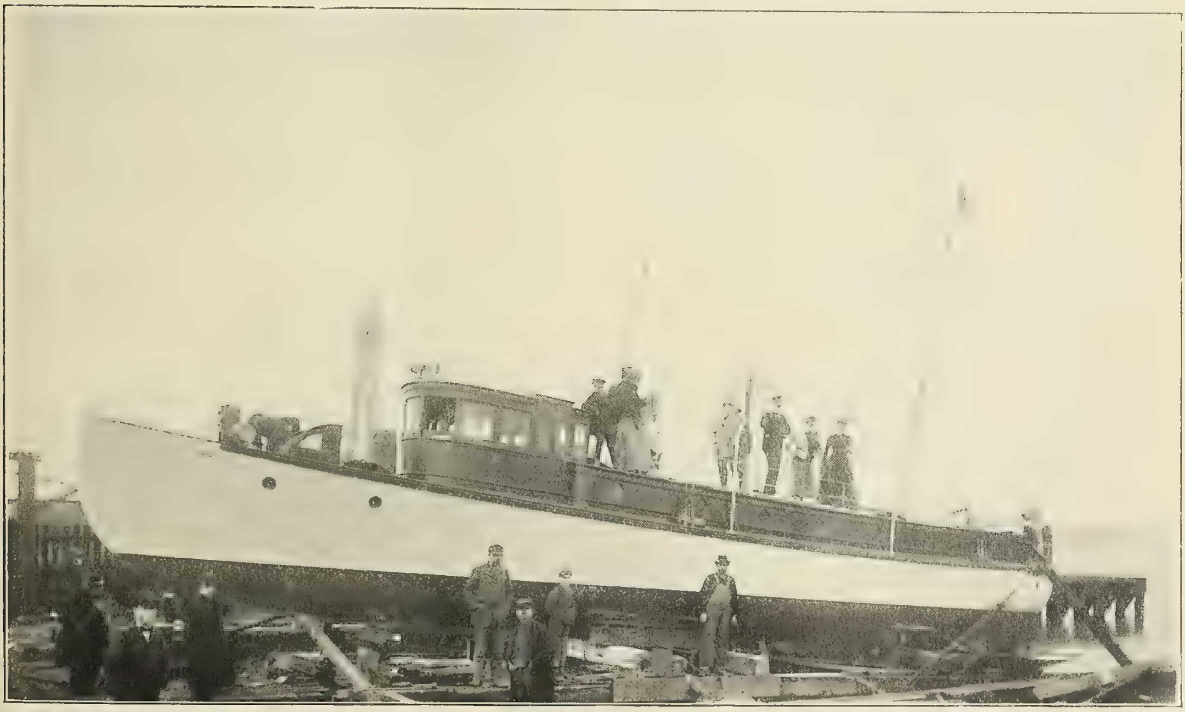
SAIL AND ACCOMMODATION PLANS OF THE 70 FT. TWIN SCREW GASOLINE YACHT LADY FRANCIS, OF BOSTON.—CONSTRUCTED AT DETROIT, MICHIGAN.



FOUR CYLINDER GASOLINE ENGINES FOR YACHT LADY FRANCIS.

fittings is placed under one of the extension bunks in the forward saloon. The main water tank is located amidships, under the floor, and there are two supplemental tanks at the stern. Hot and cold water is also supplied to the galley sink.

Two four cylinder self-starting gasoline engines are coupled to the screw shafts in the engine room aft. They are of the marine type, designed by the builders of the yacht. When starting the initial impulse in each engine is given by a powder cartridge, which is slipped into a receiver on one of the cylinders. Exhausts from the engines are carried below the water line, so that objectionable noise and odor are got rid of. Each engine is equipped with an air pump, which supplies air to a tank under a pressure of 55 lbs. per sq. in. The compressed air is used for a chime whistle and siren, operated from the pilot house. Separate engine telegraphs of the dial and pointer pattern are fitted in the engine



TWIN SCREW GASOLINE YACHT LADY FRANCIS READY FOR LAUNCHING.

room, the pilot house, and the upper steering platform. There are also speaking tubes, telephones, and call bells throughout the boat for purposes of communication.

In the engine room a two horse power gasoline engine is direct connected to a dynamo. The circuits are arranged so that the current can be supplied direct to the lamps and search light or to charge a storage battery, the batteries being placed under the floor. Small electric lamps are fitted to light the telegraph dials and the binnacles, and deck plugs and extension lamps are provided for deck use. The gasoline tank has a capacity for sufficient fuel to last on a thousand mile run.

Steel is used for the propeller shafts, and these are fitted with bronze sleeves. The wheels are of bronze also, and are four bladed, 34 in. dia.

Two boats are carried; one 14 ft. dinghey on the starboard side, and one 14 ft. motor boat, with 1 horse power engine on the port side.

Both the hull and machinery were designed by Charles B. King, of Detroit, Mich., and the vessel built by the Charles B. King Co., of that city.

COMMUNICATIONS ADDED TO THE DISCUSSIONS OF PAPERS AT MEETING OF S. N. A. & M. E.

In the seventh volume of Transactions of the Society of Naval Architects and Marine Engineers, just issued, there are interesting additions to the discussions on several of the papers read at the last meeting. These were in the form of communications received too late to be presented at the meeting. Our readers will recall the extensive report of the proceedings which appeared in our issue of December last and in which abstracts of the various papers were presented, together with the gist of the discussions. To complete the latter therefore, we now reprint such of the communications as do not appear in our original report of the meeting. They contain additional information of value and side lights which help to a better understanding of the subjects treated.

WATER TUBE BOILERS.

One of the most interesting papers offered at the meeting was that of Engineer-in-Chief George W. Melville, U.S.N., narrating the "Causes for the Adoption of Water Tube Boilers in the U.S. Navy,"[1] and it was one that especially lent itself to discussion. As the author was not present in person at the meeting, his response to the queries and criticisms of members was among the later communications, as follows:

Rear-Admiral Geo. W. Melville, U. S. N.:—"In the case of the bulging of the steam drums of the *Nashville*, referred to by the first speaker (Horace See), I regret to say that, having at the time perfect confidence in the designs presented by him, for the contractors for the *Nashville*, I accepted them, as submitted, notwithstanding the fact that the steam drums of this particular type of water-tube boiler were discussed in my office and objected to on account of being unprotected.

"Coming to grief by this equipment of boilers, I had nothing else to do than make good the defects as well as I could, and so protected the steam drums by brickwork after the damage was done.

[1]This paper was reproduced in our issue of January, page 2.

"I remember distinctly, at the time the exposed steam drums were under discussion, it was suggested that a little heat on the steam part of the steam drum would be a good thing, as it might superheat the steam.

"However, the fact remains the same, that the boilers were built in exact accordance with the plans and specifications of the designer, though, of course, this fact does not absolve me from the responsibility for accepting a defective design of boiler.

"Regarding the remarks of George W. Dickie concerning the statement that the *Monterey* had made a run of 8,000 miles, practically under forced draught, and his own statement that the *Monterey* carries but 200 tons of coal, I would say that the ship was driven from port to port where the coal pile was available, and that the ship was driven at as near full power and speed as it was possible to drive her with the limited number of engineers, firemen, and coal heavers—and for no other reason than to satisfy the Department that the ship's engines, and particularly the boilers, were or were not a failure; and the fact is that the water-tube boilers came out of this ordeal unscathed.

"It is true, as stated in the discussion, that the Scotch boilers are used for harbor purpose, and were designed and intended for that purpose, and it should be known that the back connection sheets were badly bulged on the original trial trips before the ship was commissioned, and that the harbor duty had nothing to do with the bulging of the sheets referred to. This is probably a shop secret that is not supposed to be divulged, but the whole of the Navy knows it, and a great deal of the engineering world, so I am not telling tales out of school.

"After the *Monterey's* return from South America, the back sheets were found more badly bulged, and many stay bolts leaking.

"Again, in speaking of the large amount of repairs done to the water-tube boilers, it is true that many of the tubes have been removed; in fact there is no trouble about removing the tubes without disturbing the efficiency of the ship.

"But my good friend again begs the question by neglecting to state that the *Monterey* has already had two sets of tubes for Scotch boilers.

"Regarding reducing valves, we can all very readily see why contractors would like to get rid of reducing valves simply on the score of cost and expense of putting them in. Yet we find the necessity for reducing valves not only in tubular boilers but in our good old Scotch boiler too; and though it may not be considered good engineering to carry a higher pressure in the boilers than we do at the engines, yet we seafaring men at times find it a necessity.

"No one can be so obtuse, if he should try, as not to understand what is meant by 'tactical advantages' of water-tube boilers. Mr. Dickie answers his own question when he says that he supposes that the 'tactical advantages' mean the facility or rapidity with which steam can be raised, and I am sure that he will acknowledge that there cannot be many tactics with a *steam* ship without steam. In fact the whole possibility of mobility and steering qualities at all depends upon her boilers, be they Scotch or water-tube.

"It is not necessary for me to remind any one that the cardinal principles of water-tube boilers have been large heating surface, small amount of water, and the rapid

raising of steam ready for instant use, as has been the case for fifty years in the steam fire-engine and other quick steam-generating boilers."

SHEATHING STEEL VESSELS.

Owing chiefly to the little practical experience had on this side of the Atlantic with the sheathing of steel hull vessels, there was no oral discussion of the paper on the sheathing of the U. S. S. *Chesapeake*, by Naval Constructor Lloyd Bankson.[2] Following is the written discussion from the Transactions:

WILLIAM A. FAIRBURN:—"The *Chesapeake* is an interesting vessel because she is the first sheathed vessel built in America, and the world's pioneer sheathed sailing ship. For years Naval Constructor Hichborn, Chief of the Bureau of Construction and Repair, has advocated sheathed and composite vessels, and it is very gratifying to know that at last his persistent efforts and untiring labors are bringing forth fruit. The building of gunboats Nos. 10 to 15 of composite construction four years ago was the entering of the thin end of the wedge. The *Chesapeake*, a sheathed ship, followed in 1898, and this month we have seen contracts awarded for six sheathed 3,400-ton cruisers of great fighting and sea-keeping power. It is rather strange that the first American sheathed vessel should be a small boat with a length of only 175 ft., and a displacement, deeply laden, of less than 1,200 tons. The minimum size of a sheathed vessel is usually considered about 2,500 tons to 3,000 tons, and some authorities state an even larger displacement as the minimum for a sheathed warship. In small vessels, such as gunboats, the weight of hull that can be allowed in a design necessitates eliminating the steel shell below water when the vessel is to be wood planked, and therefore a small planked vessel is always a composite and not a sheathed vessel. The *Chesapeake* is, however, a sheathed and not a composite vessel. She has a steel shell as heavy as any gunboat of her size afloat, and, besides this, she is planked with 4-in. Georgia pine up to about 19 ft. 6 in. draught.

"This sheathing is very heavy for a boat of her size, the total finished weight coppered being about 80 tons, and this thickness of 4-in. should not be taken as a basis in determining the thickness of planking in any future designs. The only reason that I can think of for using such heavy plank on such a small boat is the utilization of the displacement by weight of hull. In the design of a sailing ship like the *Chesapeake*, there is practically no machinery or coal to allow for, and as these weights are very much greater than the increased weight of spars, sails, and rigging, there is a certain margin of displacement and if the draught and co-efficient of fineness is fixed, the weight of the vessel must be increased either by ballast or increased weight of hull. The *Chesapeake* has been designed to carry about 100 tons of ballast, and the surplus weight, I suppose, has been put into the hull, for it is undoubtedly very heavy.

"The builders of the *Chesapeake* followed closely the specifications, which were very complete, during the construction of the vessel, and the specifications for sheathing quoted in Mr. Bankson's paper are but skeleton specifications or a grouping of the more important clauses copied from those of the Department. There were, however, a number of cases where it was deemed desirable to make slight changes, the method of boring the holes through the planking, and the securing of the same, being by far the most important. The fastening of the heavy teak keel was not considered sufficient, and 1 3-8 inch bolts had to be substituted for 1 1-8 inch. I am of the opinion that the width or siding of the *Chesapeake's* keel, 16 in. is not sufficient, considering the great molded depth of 26 in. and the angle of dead-rise. It proved to be a difficult matter to locate the fastenings, and get good bearing for the nuts on the inside of the ship, without boring through the rabbets of the garboard strake and coming too close to the outside of the keel. The deep curved garboard I do not consider practicable, and the builders obtained good results by working a thick garboard strake and gradually reducing the thickness, working into the mean thickness of 4 in., in four strakes of bottom planking.

"By boring the holes through the planking from the outside of the ship after it is secured in place, the prospects for getting holes square with the shell are much better than if the plank is removed and drilled on the ground or staging. By this method the plank has to be steamed but once, whereas if the plank is fitted in place and then taken down to be bored a second steaming is frequently found necessary, and the holes bored in the plank are quite often found to have quite a perceptible angle to the shell instead of being normal to the surface. If through carelessness a hole is bored through the planking on an angle, and not normal to the surface, it is much better to drill and tap through the plating on the same angle and use a tapered washer on the inside than try to rectify the evil by endeavoring to work the steel drill square and therefore elongate the hole in the plank. I have seen the latter insisted upon by inspectors, but I have not been able, as yet, to see the logic of it.

"A vessel could be planked by the method adopted on the *Chesapeake* without a single bolt coming on longitudinal vertical bulkheads or any other similar obstructions. Over 9,000 bolts were used in sheathing the *Chesapeake* and only one or two came through the shell in inaccessible places and where washers and lock nuts could not be fitted. Very intelligent men are necessary, however, to locate the fastenings of a sheathed ship. The planking should all be laid out on the vessel's bottom before the work is commenced. Then, as the planking is worked from the garboard up or from the sheer margin down, measurements should be taken from the fastening of the last secured strake for the location of holes in the next. The inside of the vessel should be inspected and these measurements checked before boring, for with plank 8 or 9 in. wide there is quite a good leeway for locating bolts. The riveting of the shell also tells quite a story, and an intelligent ship carpenter can soon be schooled to understand not only where the laps and frames are, but where the longitudinal bulkheads, buttstraps, bulkhead liners, etc., are.

"All wood ships leak, and it is impossible to build a composite or sheathed vessel that will not let some water through the plank. It may come through the seams or through defects in the plank, the bolts may leak, and some water may soak through the plank, but no builder of wood ships can keep all water out of his vessel. The leaking of a well built, well calked, com-

[2] This paper was published in our March issue, page 100.

posite ship is slight, and usually a matter of small importance, not being worthy of consideration. But every ship-builder probably knows the detrimental effect of salt water lodging between a steel hull and wood planking. If there is any space between the steel hull and planking of a sheathed vessel, water will find its way there and soon occupy it, in spite of all precautions taken to prevent it; therefore, it is quite apparent that the only way to prevent water occupying these small spaces is to fill them up with solid matter. It is impossible to lay plank against a steel hull and secure the same so that the two materials are so compact and close together that there is no space for water between them.

"The specifications of the *Chesapeake* called for a mixture of 200 lb. of red lead, 100 lb. of white lead, and 3 gal. of linseed oil well ground together, to be injected, by a suitable force pump, into holes bored in the middle of each plank about 8 ft. apart. It was required that these force pumps have relief valves loaded to 10 lb. per sq. in. pressure. A mixture of the density specified was prepared, but it was so thin that it had to be ladled. The amount of oil was finally reduced somewhat, but still the results, whilst in accordance with the specifications and the Superintending Constructor's wishes, were not very satisfactory. When first tried, I venture to say that the men got more of the red lead on their overalls than the ship received. The pressure of 10 lb. per sq. in. is much too small for work of this class, and when it is stated that this pressure is fixed so low to avoid forcing apart of the planking and plating, I think the whole thing should be treated as a good joke, for twice or even two and a half times this pressure would not prove excessive.

"After seeing the red lead injected into the space between the shell and plank of the *Chesapeake,* I cannot help but contrast it with the method which I have frequently seen of filling up the space between the armor-backing plates and the wood-backing of armor clads. I have worked a red-lead force pump myself, and my experience is that the operator can always feel his pump and tell when it has had enough. A much thicker composition should be used, for the putty softens and limbers up a good deal in working and when in the chamber of the pump. When the operator feels that the hole his pump is discharging into has received sufficient matter, a rest of a few minutes will often convince him that this is not the case, for the material travels, and he should continue to force the composition in until, on removing the pump, a little while after the last discharge, the putty flows freely from the hole. I am strongly of the opinion that the injection should be made from the inside through the steel shell wherever practicable on a sheathed ship. The plank should also be well bedded in thick red lead when laid. On the bottom the putty could be put very thickly on the inner face of the plank before it is put in place, and on the sides the shell could be well covered before the plank is forced into position.

"I do not consider that 3-4 in. brass bolts, which have an effective diameter of only 5-8 in., are large enough, as usually spaced, to secure 9 in. by 4 in. Georgia pine plank to a 3-8 or 7-16 in. well stiffened steel shell. The bearing surface under the heads of planking bolts is generally made too small, and the size of the heads of such bolts should be increased to avoid injuring, crushing, and splitting the plank when setting up. The countersinks over the bolt holes on the *Chesapeake* were plugged with Portland cement as per the specifications, which treatment agrees with the usual foreign naval practice, but I fail to see the advantage of this, and in many respects I think a pine plug is preferable, for my experience is that it insures better water-tightness.

"I would also suggest making the shell below the planking line, on a vessel like the *Chesapeake,* carvel-plated or flush, instead of the usual in and out strakes. I do not know of any scientific or practical reasoning that would condemn, on a vessel of this class and size, the use of single-riveted seam straps—the *Chesapeake* has double-riveted plate edges—therefore by making the plating flush the riveting would not prove more troublesome for wood-fastening, and it would simplify laying plank. Some of the largest foreign built sheathed vessels have but single-riveted plate edges below the planking line. If it is desired to reduce weight, what would be the objection to making the seam straps intercostal between frames, thus eliminating all liners? The edge strips have a very small area, and are not strapped, therefore they do not contribute much to the strength of the ship, and if found desirable special liners could be placed at the water-tight bulkheads—the ship's weakest section for fore and aft bending.

"The model of a sheathed ship should be especially adapted for planking. Bath sailing ships, for half a century, have been designed with this object in view. The Bath wood shipbuilder's planking lines are the modern naval architect's diagonal lines, and this fact throws some light on the fact that Bath ships have been known throughout the world for fast sailers. The *Chesapeake* has a midship section that in some respects resembles the old clipper ships, but she has steamship underwater ends and the stern is particularly bad for sailing qualities and also for planking."

NAVAL CONSTRUCTOR W. J. BAXTER, U. S. N.:—"As is well known, every endeavor must be made to prevent the presence of free salt water between the faying surfaces of steel skin plating and wood sheathing, which is covered and fastened with copper or some of its alloys. The wood sheathing should be elastic, durable, non-corrosive, and free from knots, splits, checks, or other defects which will allow salt water to filter through it.

"Yellow pine is not elastic, and it is therefore very difficult to insure the sheathing bolts being sufficiently compressed into the planking to prevent leakage under their heads; this material also contains splits and checks, which can only be found by the most minute inspection, and also frequently contains knots, all of which defects will cause leakage.

"In my opinion, teak is the best material now known which is suitable for sheathing. It is elastic, durable, non-corrosive, non-absorbent, contains few knots, and any worm holes or splits can be discovered by ordinary careful inspection.

"When salt water has once found its way behind the sheathing it is important to localize it, rather than to permit it to flow fore and aft; it is therefore of vital importance that the oakum in seams and butts should be hawsed home to the skin plating, thus reducing to a minimum the volume of those interstices which inevitably occur between the plating and the sheathing, so that salt water which may leak through any particular plank or planks, from various causes, shall be prevented

from spreading over the entire bottom. This method will also enable the red lead filling to be much more efficiently injected behind the planking, the injecting holes being spaced from 3 to 4 ft. apart on each strake of planking, commencing about 6 in. from the butts.

"Even under the most favorable circumstances water-tightness cannot be secured except by constant and minute supervision of all work on the bottom, afterwards removing planks, here and there, to ascertain the condition of the calking, filling and fastening, not otherwise visible."

Naval Constructor Lloyd Bankson, U.S.N.:—"The writer of this paper regrets that no discussion followed its presentation.

"It has been found, after docking and examination of the *Chesapeake*, after the date of the meeting at which this paper was presented, that the principal difficulty was in regard to the insufficient amount of putty pumped behind the yellow-pine sheathing. Considerable care was exercised not to injure the planking by too much pressure, and this precaution was carried too far, as an examination in dry dock showed that the spaces between plating and planking were not completely filled. Boiled linseed oil was used in making the putty pumped between the sheathing and the bottom plating. It is thought that thin putty can be used to advantage without the use of relief valves on the pumps, if careful and experienced men are employed at this special work.

"It is hoped that the *Chesapeake's* sheathing will be carefully examined at frequent intervals, in order to obtain all the practical information possible in regard to this class of work, and it is suggested that a number of 3-8-in. holes be drilled and tapped in the outside plating, below the water-line, from the inside, and closed with square-headed bolts, so they can be removed from time to time, while the ship is afloat, to determine if water has found its way behind the planking."

DENVER CLASS OF CRUISERS.

In the paper on the *Denver* class of sheathed protected cruisers by Chief Constructor Philip Hichborn, U.S.N., it will be remembered that references were made to the U. S. Ss. *Raleigh* and *Cincinnati*, which called forth responses by Engineer-in-Chief George W. Melville, U.S.N., and others in the discussion. It was thus brought out that the disproportionately large power put into these vessels was decided upon to satisfy the public demand, at that time, for ships which would equal in speed those being built by foreign navies—notably the British. Now the Chief Constructor in closing the discussion says:

Chief Constructor Philip Hichborn:—"The discussion does not appear to call for any detailed rejoinder. With reference to what has been said by various speakers about the *Raleigh* class, an examination of these remarks simply confirms my very moderate statements. They somewhat fully elucidate the 'well-known conditions' to which I referred.

"I have always regretted that the *Cincinnati* and the *Raleigh* were not given complete trials, such as would have been given had they been built by contract. Soon after their completion I urged this upon the Department, but other officials interested opposed my recommendation, and the trials were not made.

"With reference to the four-hour trial of the *Raleigh*, the displacement at which it was made is somewhat greater than the designed displacement, but this is largely accounted for by the fact that the finished weights of her machinery materially exceeded the estimated weight upon which the design was based. The quoted average speed is stated to be 18.64 knots, while during two hours of that time the average was 19.27 knots. A simple arithmetical calculation will show that for the other two hours the average was but 18.01 knots. It is not questioned that the *Raleigh* will be able for a short spurt to touch her rate of 19 knots, but it appears that after two years in commission, during a four-hour trial, she reached a speed of 19.27 knots for two hours, and only 18.01 knots for the other two hours. This seems to confirm my very mild remarks as to the maintained speed of the *Raleigh* class. It would have been interesting had the indicated horse-power maintained during this four-hour trial been quoted as well as the speed. So far as my information goes, the estimated horse-power of these vessels has never been approached in any trial, much less maintained.

"A change which has recently been authorized upon the *Cincinnati*, the sister ship of the *Raleigh*, includes the reduction of the nominal boiler power from 10,000 to 7,200, new high-pressure cylinders being fitted of smaller diameter. Concerning this change, the Chief of the Bureau of Steam Engineering, in his annual report, says:—'Undoubtedly the result, while reducing the rated speed of these ships, will really increase the speed that can properly be maintained and will greatly add to the efficiency of the vessels.'

"I think I can quote no stronger confirmation of my statement that the *Raleigh* and the *Cincinnati*, as at present arranged, have never been able to maintain a speed even approximating to the rated 19 knots for any length of time."

TORPEDO BOAT DESIGN.

Few subjects invite discussion so readily as torpedo boats. Many members present at the meeting participated in the discussion of the paper on "Tactical Considerations Involved in Torpedo Boat Design," by Lieut. A. P. Niblack, U.S.N.,[3] and to this is added the following communication:

William A. Fairburn:—"I am somewhat disappointed in Lieutenant Niblack's paper, for I had expected to read something new and original—facts gleaned by sea experience, and convincing arguments advanced by one who has the reputation of being not only an able naval officer, but a torpedo-boat expert. The paper before us is, however, nothing more than a *tout ensemble*, a massing together of Lieutenant Niblack's remarks and sweeping statements which we have heard and read during the past two years.

"Although it is a fact that almost any shipyard to-day, without traditions or previous experience, seems willing to take the contracts for high-speed torpedo-boats and destroyers, yet upon strict scrutiny we find that such firms almost invariably have in their possession plans of successful similar boats, and instead of branching out, taking great risks, and thereby courting disaster, they seem perfectly contented to follow in beaten tracks and

[3] This paper was reproduced in our issue of February, page 57.

in the footsteps of some successful torpedo-boat builder. The new successful torpedo-building firms—whether they be new firms just springing up, without any building experience, or old established firms now branching out into light construction—will be those who are now following the plans of such builders as Thornycroft, Yarrow and Normand, and the few firms which in some respects are apparently original, breaking away from old traditions and making innovations, will probably discover by bitter experience that a speed of 28 or 30 knots, although lightly spoken of to-day, is nevertheless a difficult proposition, and cannot be attained without gradual steady progression. If a firm is not willing to profit by another's experience, it must of necessity go over very nearly the same ground that other firms have traversed, and meet evils and discouragements of a similar nature to those that they have encountered and overcome in the past.

"I think that the shipbuilders who contracted to build torpedo-boats and destroyers from the United States Navy Department's designs fifteen months ago exhibited a great amount of courage. Such firms are bound down and limited on every side; they take a great deal of responsibility, and the most optimistic cannot feel confident of satisfactory results and probable success. The contractors, most of whom, however, are inexperienced firms, guarantee results without voice in the matter, and therefore exercise a blind, unreasonable faith in the Department's ability to design successful torpedo craft. Other governments, with great experience in torpedo-boat construction, and with navies containing hundreds of these little craft, have not as yet considered it advisable to prepare their own designs. I think, therefore, that it is poor policy for the United States Navy Department to attempt designing before they have had experience with various types of these vessels. There are many types of successful torpedo-boats, but when a compromise is attempted and the so-called good features of all are embodied into one design the results are usually disastrous.

"Lieutenant Niblack lays great stress upon the fact that high speed is not necessary or even desirable in torpedo-boat construction. Naval authorities, the world over, will differ with him in this broad assertion. Speed is the torpedo vessel's only protection. On a dark, thick night a torpedo-boat can steam within striking distance of a war vessel without being seen or heard on board the latter vessel. This has often been done, and, under certain atmospheric conditions, the searchlight is valueless, noise is deadened, and picket-boats and torpedo-nets are the only efficient parts of a war vessel's torpedo defense. On a clear night sound travels, and noise of any great intensity can be heard for miles at sea. Under such atmospheric conditions it is probable that the racket and dull thud of a torpedo-boat's machinery could be heard for some little distance, flames shooting from the stacks would be soon discerned, and the search-light, working under most favorable conditions, would probably locate without difficulty the on-coming torpedo-boat.

"It appears, then, that on a clear night, when the conditions are most unfavorable for torpedo-boat attack, noise and flame should be eliminated as much as possible, if the torpedo-boat attack is to prove successful. The blowers, run at high speed in order to obtain great air pressure in the fire-rooms, are the cause of almost all the noise on board a high-speed vessel, therefore a torpedo-boat should crawl up on the enemy under natural draught or with the blowers running very slowly. The fires should not be too thick on the grates, and under natural draft or a slight air pressure, with thin, carefully laid fires, no flames would shoot from the stacks to herald the vessel's approach. I do not think that flames pouring from the stacks need be considered in torpedo-boat design, for my experience is that thick, heavy fires and great air pressure are responsible for this disagreeable feature so detrimental to torpedo-boat attack. The amount of smoke pouring from the boat's stacks should be reduced to a minimum, but the quality of coal used is responsible primarily for the volume of smoke discharged from the stacks, although the air pressure has a great deal to do with it.

"Under the most unfavorable conditions for torpedo-boat attack, a torpedo-boat will probably steam a good distance within a war vessel's zone of secondary battery fire before she is discovered. Speed under natural draft, or easy steaming conditions, is therefore of great importance in a torpedo-boat, for the period that she is running the risk of being destroyed depends on the vessel's easy steaming speed for a good part of the time, and when once discovered the sooner the vessel's speed can be increased to the maximum, and the faster the vessel can steam, the less time she will be within range of the enemy's guns. The speedier the attacking boat, the sooner, therefore, she can get within striking distance of her prey, and the quicker she can steam beyond range of the emeny's guns. A 22-knot torpedo-boat cannot steam at a speed of 20 knots or more under natural draft, as Lieutenant Niblack would seem to imply, but to attain this speed she must run under forced draft and speed the blowers, which means make as much noise as the 30-knot boat would make at 27 or 28 knots speed. If the slower torpedo boat steams up to her adversary under natural draft, it will take her about as long to pass from a natural-draft speed to her full speed of, say, 22 knots as it will take a 30-knot boat to increase from 20 to 22 knots up. A torpedo-boat will be in range of the enemy's guns for a certain period of time that depends wholly on the vessel's speed, providing she is not disabled. Therefore the protection of a 30-knot boat compared with that of a 20-knot boat is in the ratio of three to two.

"I have seen more flame shooting from the stacks, more water commotion, and heard much more noise on a high-speed torpedo boat of 25 or 26 knot speed than I have ever seen and heard on a boat steaming at a speed of 30 to 31 knots, and from reports that I have received it appears that our 22 to 24 knot boats make a great deal more fuss and noise at this speed than our latest torpedo-boats make at a speed of 30 knots.

"Lieutenant Niblack asks if a 30-knot boat can pass from a speed of 20 knots to 30 knots in a period of 30 seconds. A well-designed, 30-knot torpedo-boat could steam quietly under natural draft at a speed of from 20 to 22 knots per hour. If the order should be given for full speed ahead, the blowers could be started in the fire-rooms immediately at full speed, and if the risk of getting a little water over from the boilers into the engine cylinders is accepted, the little vessel could in half a minute be ploughing through the water at approxi-

mately her maximum speed. I will admit, however, that the gradual speeding of the blowers, and therefore the gradual rise in speed, is by far the best for the light, quick-running machinery, but, nevertheless, if speed has to be raised rapidly, it can be done, for it has been done on several occasions to my knowledge. I have frequently been on board a 140-ton boat of this type that steamed quite easily with open stokehole, and the blowers running slowly at a speed of 25 knots per hour at sea.

"Three years ago, whilst in Scotland, it was my good fortune to watch the construction of a number of torpedo craft building at that time on the Clyde for the British and foreign governments. In quite a number of cases the boats building for the foreign governments had to undergo a measured mile test full speed astern. If I remember aright, a speed astern equal to two-thirds full speed ahead was guaranteed by the builders, and in every case slightly exceeded. A number of naval officers, representing the navies for which the vessels were building, frequently expressed the opinion that the best way to attack a war vessel with a torpedo-boat or boats is to steam rapidly toward the enemy, bows on, so as to offer as small a target as possible to the shot, reverse the engines, discharge the torpedo from forward, and steam out of range of the enemy's guns, full speed astern, before turning a broadside to them.

"The arrangement of torpedo tubes on American boats is, in my opinion, crude and most inefficient. The stern tube, to which the Bureau of Ordnance fondly clings, cannot be fired when the vessel is under way, and it is therefore practically valueless. The midship tubes are undoubtedly desirable and necessary, but when using these guns the torpedo-boat presents generally a full broadside as a target for the enemy's rapid-fire battery. It is well to note, however, that when a boat is steaming full speed ahead, the tubes located near midships are the only ones that can be used with probable success. Although the bow torpedo tube is not in favor in this country, yet there are times when such a tube would prove of great value. Foreign naval officers appreciate this fact and 90 per cent. of torpedo-boats in the navies of the world are fitted with bow tubes. The only argument against them that I have heard advanced is the danger of a boat running into its torpedo before the latter has had time to attain its high rate of speed. This argument is not sufficient to warrant condemning the bow tubes in torpedo vessels, for when the torpedo-boat fires its torpedo, after steaming head on to the enemy, the engines could be reversed, and under bells—full speed astern—instead of following her torpedo she could steam as rapidly as possible in the other direction, out of range of the enemy's guns.

"I should like to know why the 3.55m. (short) Whitehead torpedo has been adopted for the later torpedo-boats of the United States Navy, instead of the 5m. (long) Whitehead torpedo, which is generally considered far preferable.

"I agree with Lieutenant Niblack in his remarks concerning the relative merits of single and twin screw boats. Draft and stability have to be seriously considered in this question, however, and I think that they will usually limit the power applied to a single shaft on a torpedo-boat to about 2,000 I. H. P. The bow rudder is a very desirable feature that ought to be adopted in all torpedo-boat designs, especially for second-class inshore and harbor boats. I do not follow Lieutenant Niblack when he says that, in turning, the pivot of our twin-screw boats is almost at the forefoot and a bow rudder would shift the pivot to about amidships, and improve the manœuvring power considerably. The first action of the rudder when it is put over tends to turn the vessel about an instantaneous axis, but when the sideward drifting of the ship becomes equal to the transverse component of the pressure on the rudder, the ship continues to turn about the centre of lateral resistance under the action of the couple-pressure on rudder multiplied by distance between centre of pressure of rudder and center of lateral resistance. If the deadwood of a vessel is cut away aft, the manœuvring qualities of the boat will be much improved, owing to the centre of lateral resistance being moved forward; but although this is a desirable feature as it also reduces somewhat wetted surface and weight of hull, it should be borne in mind that it injures the boat's weatherliness and steadiness in a seaway. The experiments made by Normand with bow rudders prove that with his boats such rudders divided the tactical diameter by two. My experience is that a bow rudder is absolutely essential in a torpedo-boat that has a stern rudder forward of the screws. When steaming at full power it takes but a small angle of helm to make a barn-door rudder interfere with the flow of water to one of the propellers, and at full speeds, with helm hard over, the excessive racing of a propeller wheel brings great stresses upon machinery which must of necessity be more or less delicate. Therefore, although at low speeds a twin-screw sea-going torpedo-boat may be handy and manœuvre well, yet quite often, when the rudder is forward of the screws the helm angle at high speeds is so limited that the tactical diameter of the vessel is much too great. A bow rudder that when not in use can be housed in a well above the line of keel would overcome this evil.

"Lieutenant Niblack advocates building torpedo-boats from identical designs with standardized fittings. This is, in some respects, an excellent idea, provided that we have a type that has given very satisfactory results, and which will stand comparison with the best existing foreign types. But yet this scheme has many disadvantages. If we were to build year after year torpedo vessels of a type standardized by the Navy Department, there would be no incentive for private shipbuilding firms to experiment and vie with each other in the production of first-class, efficient, economical vessels. If it had not been for the untiring efforts of four torpedo-boat building firms, there would be no 30-knot torpedo-boats and destroyers ploughing the waters to-day. Yes, I will go even further, and say that if each government had in the past persisted in standardizing and designing their own torpedo-boats, the successful high-speed torpedo craft of to-day would not be in existence. If torpedo-boat builders were called upon to make fittings for the boats that they have designed and are now building, based upon the average naval officer's idea of what standardized torpedo-boat fittings should be, I would venture to predict that the weight of hull would increase to such an alarming extent that the designers and builders would be compelled to insist upon a reduction in trial speed. I have examined torpedo craft built by inexperienced firms and been astounded at the useless

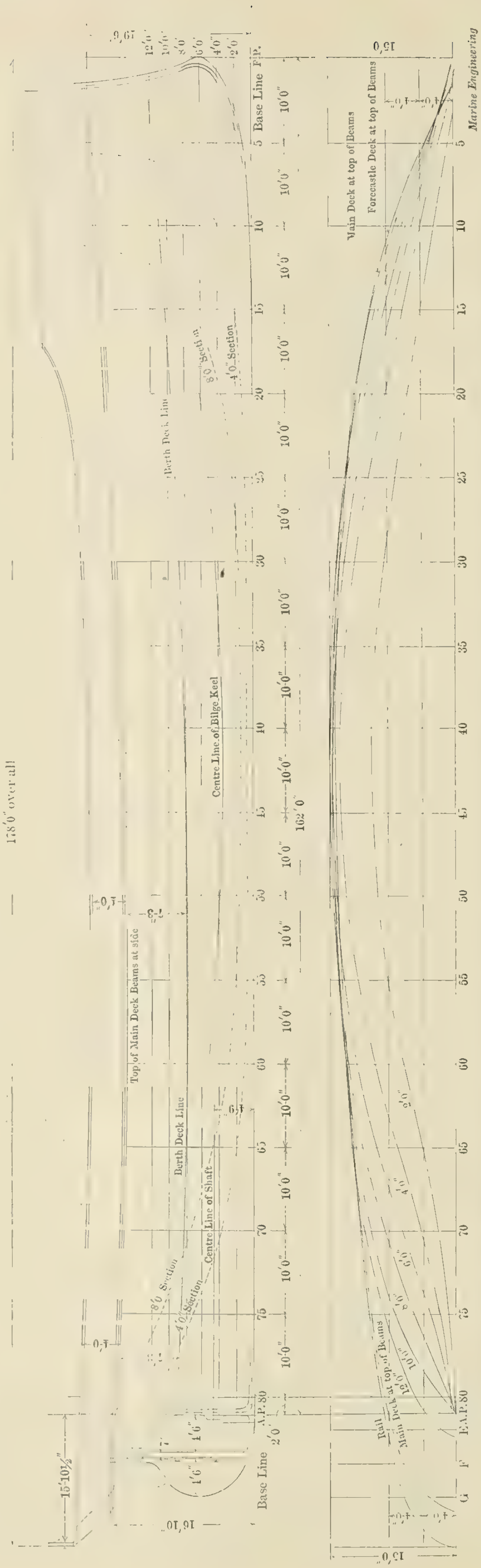
weight put into detail fittings. The total weight of hull in such boats seemed quite reasonable, but the strength members of the ship had been reduced almost below the safe minimum in order to allow for big ship fittings and equipment. A strong vessel, high speed, and battleship fittings do not go together in torpedo-boat design. The first is essential, and if the last is insisted upon, machinery of less weight and therefore less speed follows.

"If it were not for some very strong remarks made by Lieutenant Niblack at last year's meeting of the Society, I should ask him if a standardized fleet of sea-going torpedo-boats of the *Foote, Rowan, Davis,* or *Ericsson* type; a fleet of second-class boats of the *Mackenzie* and *McKee* type, and a fleet of vedettes similar to those built for the *Maine* and the *Texas,* would harmonize with his ideas. Personally, I think that it is better to have ten boats all different and three of them successful than to have ten standardized boats all utter failures. But Lieutenant Niblack has gone on record as saying that there is only one firm in this country capable of building torpedo-boats, and he regrets that the Navy Department does not award all the contracts for the construction of these vessels to this firm. The firm in question is undoubtedly a very successful one, by far the best thoroughly original American firm, but a speed of about 28.5 knots on a displacement of approximately 170 tons is its best performance. It has built machinery that weighs 51 pounds per I. H. P., and obtained 23 I. H. P. per square foot of grate. Is it fair to the American builders of torpedo-boats who have produced boats that have attained a speed of 30 knots on a displacement of less than 140 tons, and to builders of a very successful 30-knot destroyer, to say that there is only one firm in this country capable of building high-speed craft? The *Dahlgren's* splendid performance cannot be equalled by any other shipbuilding firm in this country. The builders of this boat have obtained over 4,200 I. H. P. with two water-tube boilers and 35 I. H. P. per square foot of grate. The machinery weighs only 41 pounds per I. H. P., and this small weight has been obtained with a long stroke engine turning up to only 318 revolutions per minute—a piston speed of 1,100 ft. per minute.

"The torpedo boat must of necessity be a refined machine. Mathematics and science must take the place of the two-foot rule and the about-so-much method of proportioning scantlings and details. High-grade material must be used so as to keep the factor of safety reasonably high, with minimum weight. A light, refined machine, however, does not mean a weak, flimsy production. Weight does not necessarily mean strength. Far from it, for there are torpedo-boats afloat that in actual service, if well cared for, will stand as much wear and tear as the average heavily built cruiser. Some of the most rugged, durable, best, and easiest running machinery that I have ever seen has been modern high-speed torpedo-boat machinery."

Charles Fletcher, of Providence, R. I., has placed an order with the Harlan & Hollingsworth Co. for a twin screw steam yacht, 212 ft. long.

A combination on terms of mutual agreement has been effected between the Atlantic Transport Line and the Leyland Line, making a practical consolidation of $25,000,000 capital, and the services of a fleet of 48 passenger and freight steamships.



LINES OF THE STEEL SINGLE SCREW U. S. REVENUE CUTTER FOR SERVICE ON THE GREAT LAKES.—SHEER AND HALF BREADTH PLANS.—SEE PAGE 161.

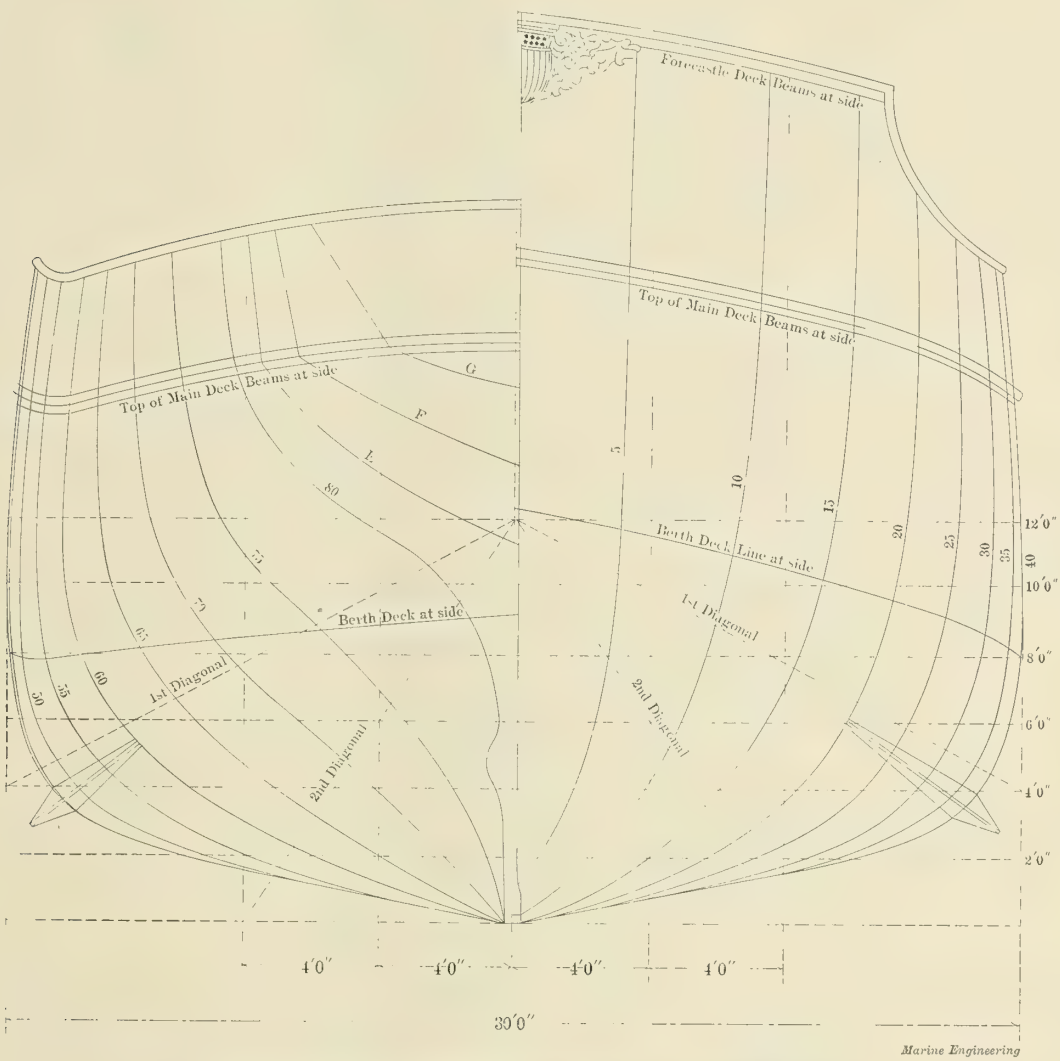
SINGLE SCREW STEEL U. S. REVENUE CUTTER FOR THE GREAT LAKES.

Bids for the construction of a new revenue cutter for the Great Lakes were opened at Washington recently as follows: American Shipbuilding Co., Cleveland, delivery on or before May 1, 1901, $150,000; Chamblin & Scott, Richmond, Va., delivery in 12 months, $163,500; Townsend & Downey, New York, delivery in 12 months, $151,000; William R. Trigg Co., Richmond, Va., delivery on or before May 28, 1901, $157.000. This was the first appearance of the second named bidders in competition.

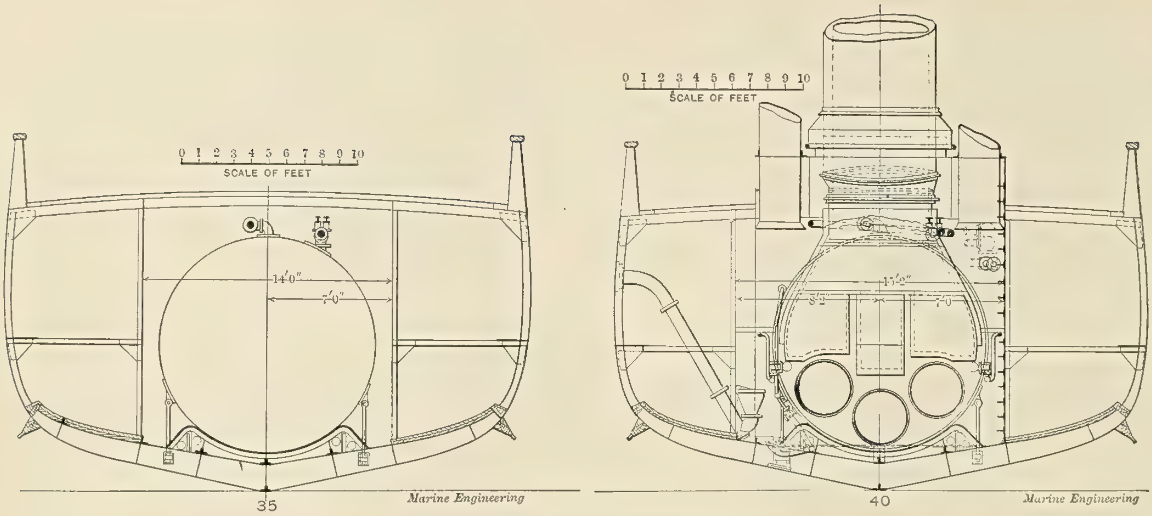
This firm is composed of John C. Chamblin and James H. Scott, both of Richmond, who have now extensive facilities for engine work, and who, it is understood, are prepared to put in a plant for hull construction if awarded the contract.

The new revenue cutter is to be a steel single screw vessel of about 620 tons displacement. Her general dimensions are: Length over all, 178 ft.; beam, moulded, 30 ft.; depth, to base line, 15 ft. Captain Russell Glover, R.C.S., superintendent of construction, designed the hull. This will be of mild open hearth steel of a tensile strength of 55,000 lb. per sq. in., with an elongation of 25 per cent. in 8 in. Physical tests to be applied require that the material must withstand bending traversely back on itself without sign of fracture. This grade of material has been found satisfactory in every way for use in the construction of the hulls of revenue cutters. The frames are made of 5 in. by 3 1-4 in. by 3 1-4 in. Z bars, spaced 2 ft. centers and secured to a vertical keel plate of 15 lb. steel, about 21 in. deep. The floor plates generally will be 18 in. deep next to the vertical keel, while in the engine and boiler space they will be extended up so as to form a part of the foundations for the engine and boiler. The outside plating up to the line of the main deck will be of steel 15 lb. per sq. ft. The stem will be slightly ram shaped. The stem and stern post will be forgings of wrought iron.

The hull is divided into compartments by four water-tight bulkheads. The quarters for the commissioned officers are located on the berth deck aft of the engine



BODY PLAN OF U. S. REVENUE CUTTER.—DRAWN TO ENLARGED SCALE.



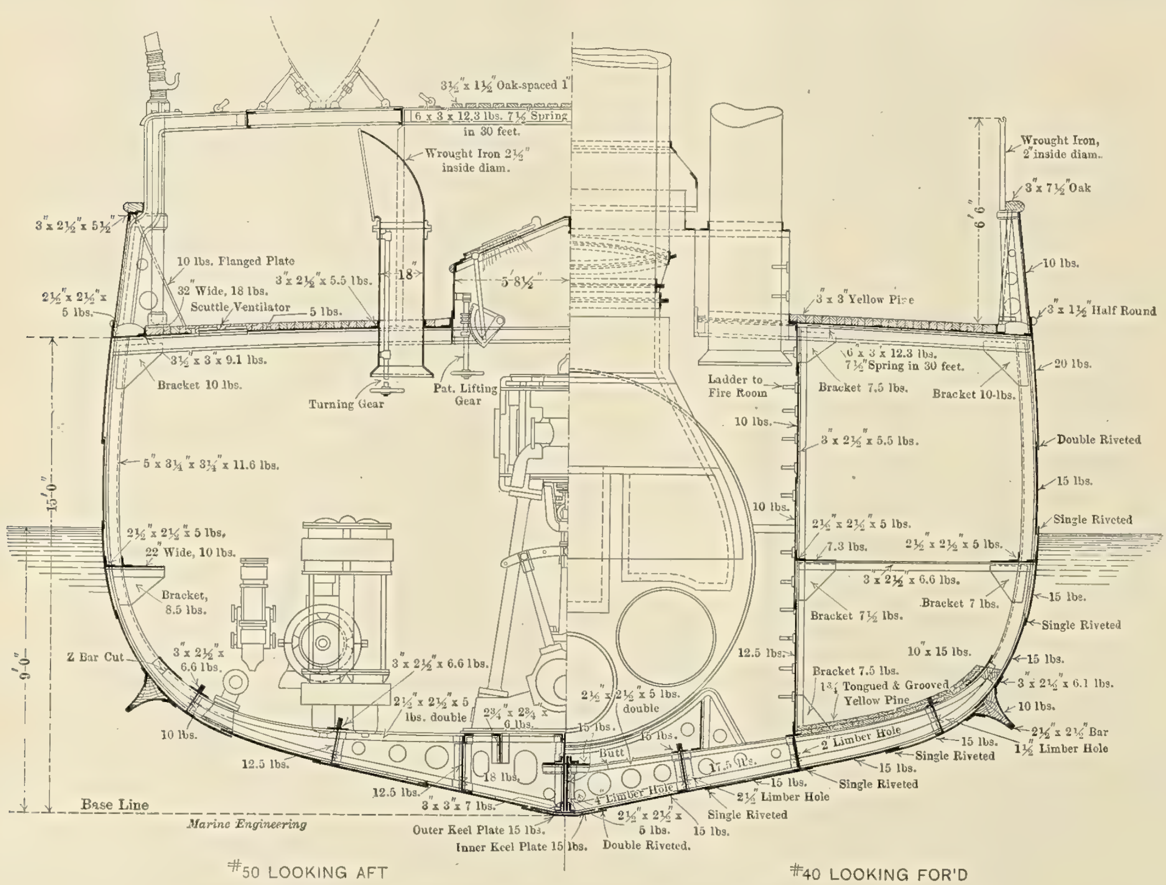
ARRANGEMENT OF MACHINERY OF REVENUE CUTTER.—CROSS SECTIONS AT FRAMES 35 AND 40.

compartment, and the quarters of the petty officers and crew are forward of the boiler compartment. The accommodations for the crew, as well as for the officers, are comfortable, and every care has been exercised to make the conditions of life on board ship as pleasant as possible. To this end the sanitary system of the vessel has been made very complete, shower baths and running water being provided for the crew, and the water closets being continuously flushed.

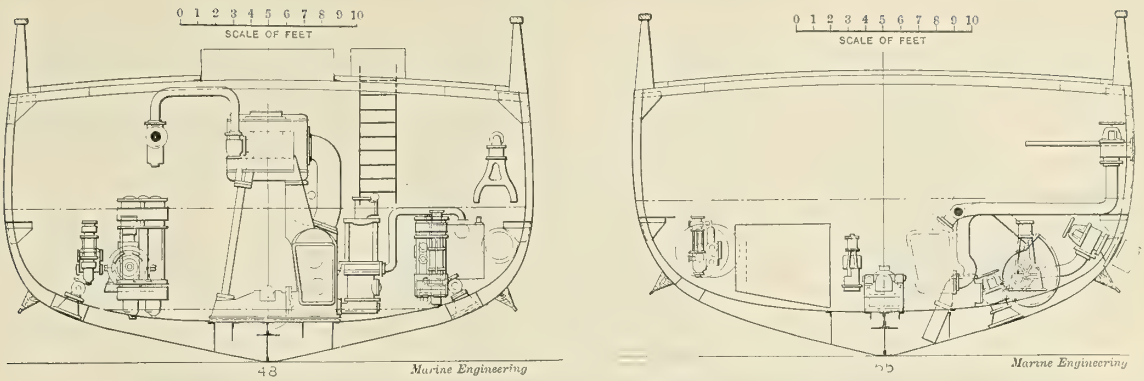
The pilot house and chart room are to be located on the forecastle deck forward of the smoke pipe, and a bridge will extend across the top of the pilot house to the ship's side.

Two bower anchors will be provided, each weighing about 1,800 lbs. They will be secured to 1 1-4 in. stud link chain, provided with shackles every 15 fathoms. The anchors are to be of the stockless type.

Provision will be made for carrying a certain amount



CROSS SECTION OF U. S. SINGLE SCREW REVENUE CUTTER FOR THE GREAT LAKES.

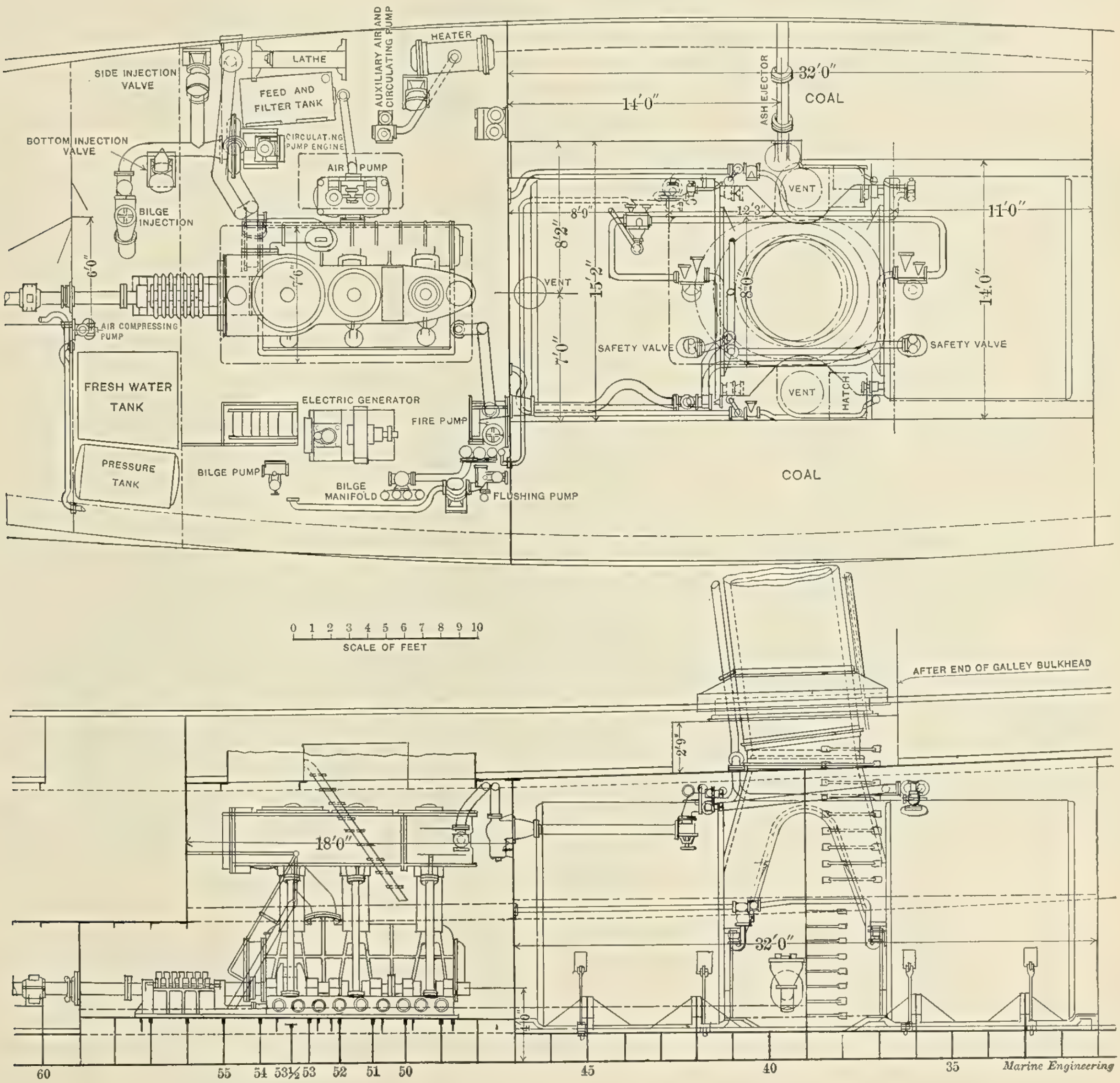


ARRANGEMENT OF MACHINERY OF REVENUE CUTTER.—CROSS SECTIONS AT FRAMES 48 AND 55.

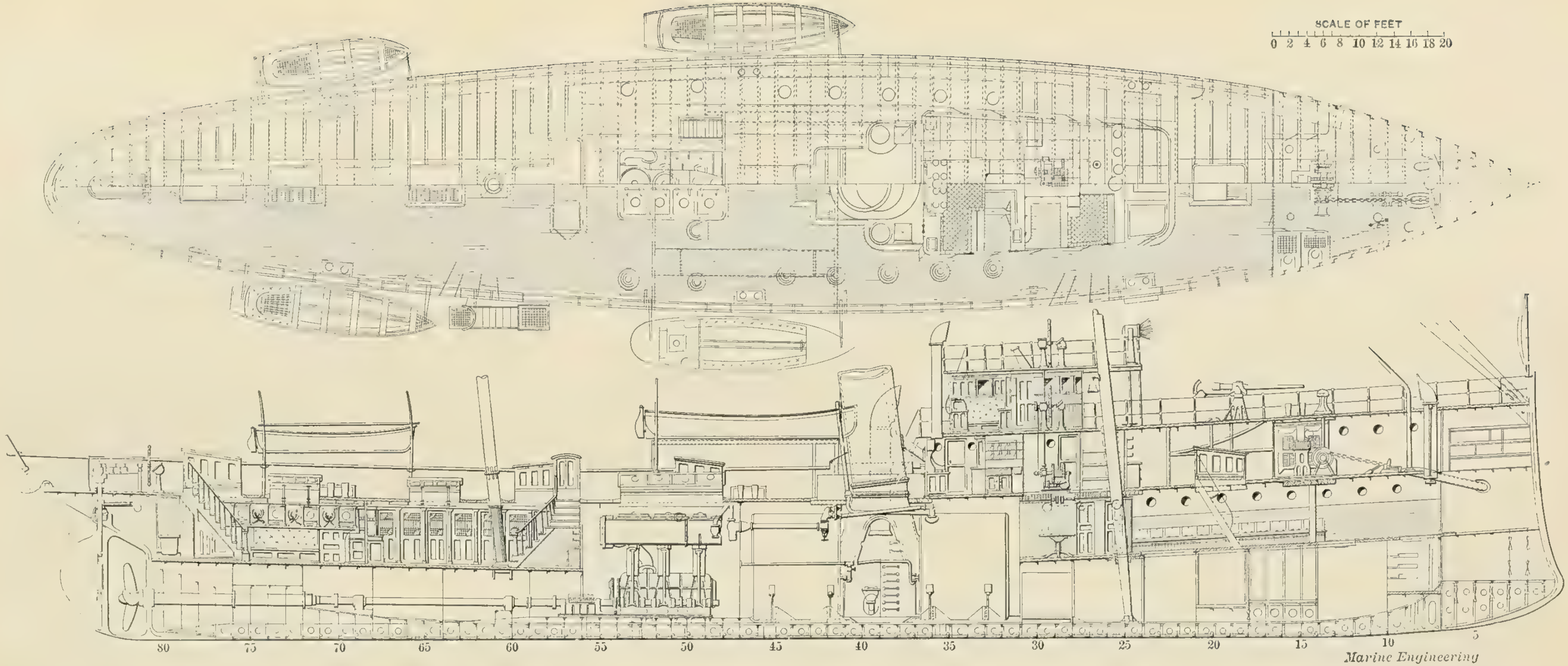
of sail, principally to be used for steadying purposes in a seaway. For this purpose the vessel will have two steel masts, each about 80 ft. high, above the main deck.

The propelling machinery of the vessel, which it is expected will give her a speed of 14 knots at full power, was designed by Captain Jno. W. Collins, R.C.S., engineer-in-chief, who also has charge of the electric light, sanitary and steam heating systems, and the inspection of all material.

A triple expansion engine designed to develop 1,200



OUTLINE OF MACHINE SPACES U. S. SINGLE SCREW REVENUE CUTTER.—PLAN AND ELEVATION.



PLANS OF THE NEW STEEL SINGLE SCREW REVENUE CUTTER FOR SERVICE ON THE GREAT LAKES.—LENGTH OVER ALL, 178 FT.; BEAM, 30 FT.; DISPLACEMENT, 620 TONS.

I. H. P., at 195 revolutions, with 175 lb. initial pressure, will be fitted. This engine has cylinders 17 in., 27 in. and 43 in. dia., and 24 in. stroke. A piston valve will be fitted to the high pressure cylinder, and double ported slide valves for the other cylinders. All boxes will be fitted with Katzenstein's metallic packing.

Steam will be generated in two Scotch boilers, each with three corrugated furnaces. The total grate surface of each boiler is about 55 sq. ft., and the total heating surface about 1,650 sq. ft. The shells will be 12 ft. dia. and 1 1-8 in. thick, each made up of two plates. The overall length of the boilers is 10 ft. 3 in. The horse-power per square foot of grate surface is expected to be about 11.

The condenser will form a part of the framing of the engine and will contain about 1,350 sq. ft. of cooling surface made up of 793 Muntz metal tubes 5-8 in. outside dia., No. 16 B. W. G.

The air pump will be an independent single-acting twin air pump secured directly to the condenser. It will have two steam cylinders, each 7 1-2 in. dia., two air cylinders, each 16 1-2 in. dia., stroke being 10 in.

The circulating pump will be of the centrifugal type, having 8 in. suction and discharge, and directly connected to a 7 in. by 7 in. vertical engine. The pump will be connected to the sea by two injection valves, and to the bilge by a bilge injection and a Macomb strainer.

A feed water heater is to be provided, having about 120 sq. ft. of surface. This heater will receive the exhausts of the auxiliaries on the outside of the tubes, the feed water passing through from the feed pump to the boiler. The heater will be provided with a combined air and circulating pump, so arranged that when the vessel is not under way, the heater can be used as an auxiliary condenser for such auxiliaries as require to be kept continuously in operation.

The feed pump is to be of the duplex pattern, having steam cylinders 7 1-2 in. dia., water cylinders 4 1-2 in., and a stroke of 8 in.

Besides these auxiliaries, the vessel will be fitted with steam steering gear, steam windlass, fire and flushing pumps, etc., so as to make her thoroughly efficient in every way.

The auxiliaries are to be connected so as to exhaust into the main condenser, the heater, or the receiver at will. By the latter method an economy approaching that of the main engine can be obtained for the auxiliaries, and still all the advantages of separate auxiliaries retained.

The propeller will be a solid cast steel wheel, 8 ft. dia.

In the accompanying drawings the general arrangement of the vessel and her lines are shown; also the arrangement of the machinery spaces.

U. S. Torpedo Boat Somers.

Our illustration shows the German built torpedo boat *Somers* on her way to undergo a speed trial in Long Island Sound. The results of this trial, recently held, as shown by the report of the Board of Inspection, were not entirely satisfactory—a sea speed of only 17 1-2 knots being attained. The Board recommends that the boat be used for harbor defense. It will be recalled that this little vessel was purchased in Europe shortly before the breaking out of the Spanish war, the purchase price being $72,997. An attempt was made to get her across the Atlantic under her own steam, but this failed, and the war breaking out about that time, she was tied up at an English port until its close. After the war the *Somers* was brought across on the deck of a liner. At the Brooklyn Navy Yard her machinery was lifted out and some needed repairs were made. Her dimensions are: Length, 149 ft. 3 in.; beam, 17 ft. 4 in.; displacement, 143 tons. She is fitted with a single screw, driven by quadruple expansion engines of 1,700 rated horse power, and a boiler of the locomotive marine type. Her bunker capacity is 30 tons, and her "estimated" speed was 23 knots.

GERMAN BUILT U. S. TORPEDO BOAT SOMERS STEAMING AT SLOW SPEED.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATERIAL.—III.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

In 1885, when Mr. Whitney became Secretary of the Navy, there was inaugurated a period of great activity and progress in the Navy Department, taking what had been done by Secretary Chandler, who started the new navy, and carrying on the work along the lines of logical development. Mr. Whitney's determination was to have ships which should be fully the equals of those in any country, and it was through him that the speaker was called to the position of Engineer-in-Chief of the Navy in 1887, succeeding his life-long friend, Commodore Loring, one of our past presidents, whose reputation as an engineer is too well known to all of you to need any praise from me.

I desire, in this connection, to say that no head of an office has ever been more fortunate in the young men who have been his assistants. No one has ever had the co-operation of abler men, and this has always been rendered with a loyalty and cordiality which deserve all the praise I can give, and I say with perfect frankness that if the progress of naval engineering in our country has been great during the past twelve years, it is due, in a large measure, to the cordial assistance of the talented young men who have worked with me.

I believe it is generally admitted that the machinery of our navy has been in all respects fully abreast of the latest developments, and in many respects we have taken the lead. One of the first things which may be mentioned is the fact that during the period before water tube boilers were used in any navy, and when in some foreign navies there was a great deal of trouble with the shell boilers, due to the effort to get an abnormally large amount of work out of them, we had no such trouble. We believed in the principle of

* President's address (1899) at New York meeting of American Society of Mechanical Engineers.

never sending a boy to do a man's work, and as a result we never had a boiler incapacitated through leaky tubes, and never lost a trial trip on this account, while failures of this sort were very common things abroad.

One of the first things we did was to establish the use of water tube boilers and light compound engines for our steam launches. Private builders in this country had used water tube boilers, but the results, owing to the type of boiler employed, were not altogether fortunate. We found a boiler which has proved entirely satisfactory, and also developed light machinery which was also sufficiently substantial to stand the comparatively rough handling with which the machinery of small boats must inevitably meet. We are to-day the only navy which uses water tube boilers exclusively in its small boats. When we started, the effort was made to save as much water as possible, and small blowers, run at a high speed, were used for draught, but the inevitable hum caused so many objections to be entered by officers of high rank that we were driven to the use of the steam jet. It was, of course, important that the most economical form of jet should be used, but when we came to determine this question we found that there were absolutely no reliable data in existence. As a result, we carried out a valuable series of experiments at the New York Navy Yard, and found an exceedingly simple form of jet, which was also very economical, giving us a fairly high rate of combustion for a comparatively small expenditure of steam.

It was evident to us that with the prevailing tendency toward continual increase of speed and power, with the accompanying increase of steam pressure, the shell boiler would at some near date have to be superseded by the much lighter water tube boiler, and we therefore invited a competition among the various manufacturers of water tube boilers, with a view to determining the one which, all things considered, would be best adapted to naval uses. Although this competition occurred about ten years ago, you are doubtless familiar with the circumstances, and that, as a result, we installed about 5,000 horse-power of Ward boilers in the coast defense vessel *Monterey*, this being at the time, and for several years, the largest installation of water tube boilers in any naval vessel. I am glad to say that these boilers have always given satisfaction, and are still in use. At this same time water tube boilers of a different type were installed on one of our torpedo boats, and we have never used any other than water tube boilers on any of the numerous torpedo vessels which have been built since.

It would have been an easy matter, and it would have brought temporary praise to the Engineer-in Chief, if, after the successful trial of the *Monterey*, we had at once launched out into the use of water tube boilers for all our vessels; but we felt that there had not been sufficient experience in their use to warrant us in making such an experiment in our first seagoing armorclads, and consequently, for a number of years, and even after foreign navies had begun to use water tube boilers extensively, we continued to use the shell boilers in our large vessels. Two years ago, when I felt that there had been sufficient experience to warrant us in the final adoption of water tube boilers, I recommended in my annual report to the Secretary of the Navy that we should definitely adopt water tube boilers for all classes of vessels. For reasons altogether apart from the machinery, we were not at first successful in securing water tube boilers in the department's own designs in spite of my urgent recommendation, but the firms which tendered on the government's designs also offered to guarantee higher speeds if they were allowed to use water tube boilers and more powerful machinery in hulls of their own design. This I had advocated very strongly, and both the technical and daily press of the country had supported this position very heartily, believing that it would be a woeful mistake for our country to build sixteen-knot battleships when the rest of the world were building ones to make eighteen knots, and when by the use of water tube boilers we could so readily do it. I am glad to say that the department accepte the builders' offer, thus definitely adopting water tube boilers and securing the eighteen-knot battleships for which I had worked so hard. At the present time all our new designs include water tube boilers exclusively.

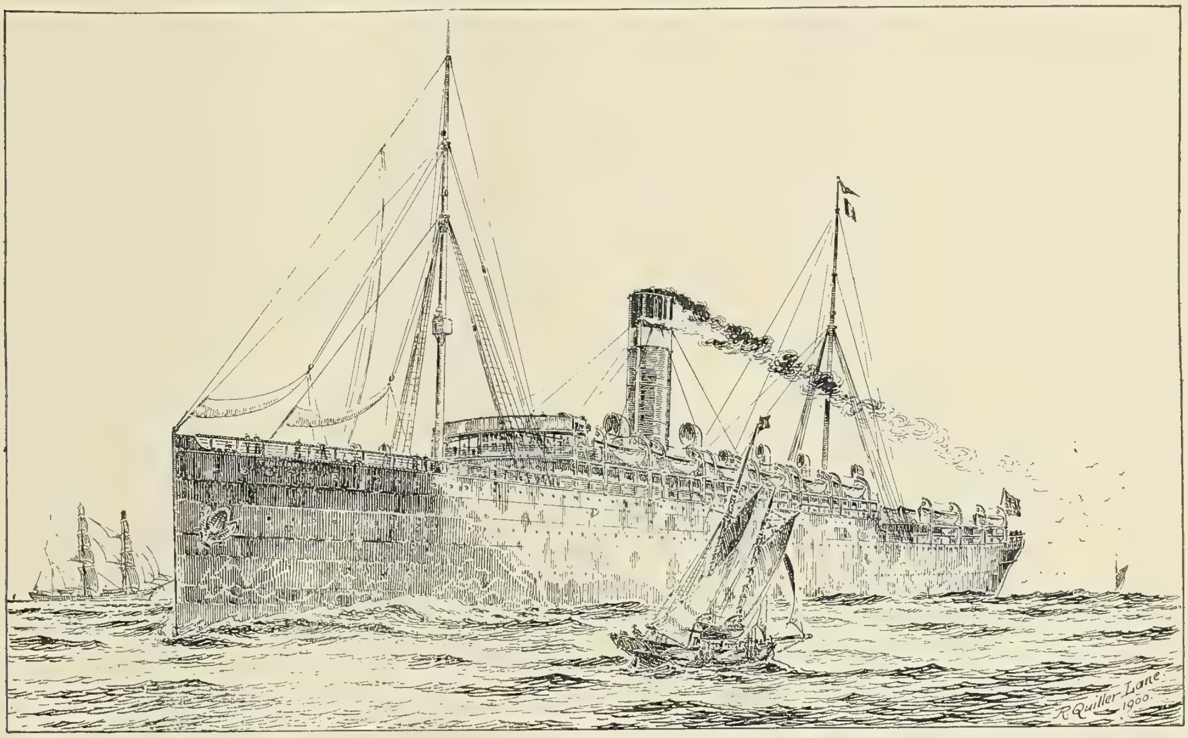
One of the notable improvements in design which we introduced for large vessels was the use of triple instead of twin screws. We were not the originators of this method, as small vessels in both France and Italy had demonstrated its success, and both France and Germany were building vessels of about 12,000 horse-power with this system of propulsion. When it came to the design of the *Columbia*, the first of our commerce destroyers, with 21,000 horse-power, I was satisfied, after careful study of the problem, that we would need to use triple screws to attain success. At the beginning I did not anticipate an economy in propulsion, and the adoption of triple screws was for structural reasons; but when the *Columbia's* trial occurred we found that there was a material increase in the propulsive efficiency. When the *Minneapolis* was tried, shortly afterward, with the same system of machinery, this fact of greater economy was again established, so that we now feel that triple screws are justified not only for numerous other reasons, but on the ground of economy. This arrangement of propellers has become very popular in a number of foreign navies which have followed it out on a considerable scale, and have built all their large vessels with triple screws. It is probable that we shall do the same thing in our larger ships of the new programme.

During our late war with Spain we developed and utilized two engineering schemes which had never previously been tried in actual service—a repair ship and a distilling ship. The former is one phase of the modern method of treating large work by taking the tool to the work instead of bringing the work to the tool. The *Vulcan* was the equal of anything except a very large repair yard, and after the battle of Santiago she was almost invaluable in the much needed general overhaul of all the ships. Besides an admirable outfit of machine tools and engineering stores, the *Vulcan* was specially notable for using the first cupola ever installed on board ship. The distilling ship was fitted with a four-unit triple-effect distilling apparatus capable of furnishing 50,000 gallons of fresh water per diem after use for some time with an economy of over

twenty pounds of water per pound of coal burned under the boilers. With clean coils the *Iris* actually furnished over 100,000 gallons per diem. The bunker capacity is 3,000 tons of coal, thus giving a potential capacity of distilled water of 60,000 tons, or as much as twelve of the largest tank steamers. The advantages of a distilling ship over a "tanker" are very numerous and obvious.

Allan Liner Tunisian.

A large liner for transatlantic service was recently put into the water at the yard of Alexander Stephen & Sons, on the Clyde. This was the S. S. *Tunisian*, 10,200 gross tons, built for the Canadian trade of the Allan line. She is of the money earning, intermediate type, with large passenger accommodation and freight capacity and moderate speed. In dimensions the *Tunisian* measures: Length over all, 520 ft.; beam, 59 ft.; depth, 43 ft. In the accompanying sketch the artist has depicted the new liner at sea, and it will be readily conceded that she presents a noble appearance. There will be accommodation for 200 first-class passengers on the upper bridge deck, 250 second cabin, on the after part of the bridge and on the upper deck amidships, and a considerable number of steerage passengers on the upper deck aft, the latter being berthed mostly in separate rooms. The main saloon occupies the forward end of the bridge deck, being well lighted from three sides and also from a handsome cupola. Most of the first-class cabins are located in a spacious deck house on the upper bridge deck, and on this deck are also the music room and smoking room, these latter rooms occupying the ends. She will have twin screws and triple expansion engines.



NEW S. S. TUNISIAN, 10,200 GROSS TONS, FOR ALLAN LINE IN TRANSATLANTIC TRADE.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—I.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

The purpose of this paper is to show the trend of foreign naval opinion and development, as represented in the professional press and other publications, on subjects of current interest. These foreign views and tendencies are given as being worthy of consideration, but not as being necessarily applicable to our own service.

INCREASE OF NAVAL STRENGTH.

In considering the principal foreign navies with a view of noting recent tendencies of development, the most striking feature which presents itself is the marked effort now making by the important maritime powers to increase their naval strength. Never before, except, perhaps, spasmodically during a naval war, has such endeavor been more vigorous or more general. Whether recognition of this be accorded willingly or unwillingly, it must be reckoned with. The importance of sea power is clearly perceived, and naval shipbuilding programmes grow more extensive and more elaborate.

TYPES OF SHIPS.

In the apportionment of new tonnage abroad the large share set apart for battleships, notwithstanding their great cost, shows that responsible foreign opinion regards them as constituting the real fighting strength upon which reliance must be placed to win naval battles. This view was held long before the Spanish ar-

* From Notes on Naval Progress, issued by U. S. Office of Naval Intelligence, Washington, D. C.

mored cruisers were destroyed at Santiago, but it now meets with general acceptance, and the assertion that the building of battleships is a wasteful use of money and resources is seldom heard. In France and in Italy, for special reasons, the armored cruiser is still held in relatively high esteem, and in the French press the claim has been persistently urged that the battleship will be deprived of its value by the submarine boat; but following this comes a recent request by the Minister of Marine for authority to lay down additional battleships for the French navy.

As battleships are intended to have the greatest possible fire energy, with the best protection attainable, their gun fire must be the maximum which their displacement will permit; and the latest foreign expert opinion is practically unanimous that their armor must not only protect the water line and the gun positions, but that the hull and the personnel must be effectively sheltered.

The typical features of the battleship, maximum offensive and defensive power, are not dependent on circumstances, but are ready at all times. Speed varies with conditions of service, and for battleships is regarded as a secondary consideration, although a very important one. The anxiety which the monitors caused Admiral Sampson has impressed anew upon foreign observers the need of strategic mobility. Other things being equal, the more efficient of two fleets of battleships will be the one whose slowest ship is faster than the slowest ship of the enemy. The aim abroad now is to have the battle fleet composed of ships having great offensive power and the best protection obtainable, with a minimum speed of not less than fifteen knots. While some of the units may be capable of eighteen knots, there should be none that cannot be depended on for tactical evolutions at fifteen knots speed. To attain this obsolete vessels must be replaced or modernized in accordance with the latest developments in engineering.

Next in importance to the battleships is the armored cruiser, which forms a prominent feature of the latest foreign shipbuilding programmes. Vessels of this type have primarily high speed and great coal endurance. They are usually of large size and are given as much protection and as intense fire energy as practicable, but these qualities are secondary, while they may be used to supplement the fleet of battleships, if necessary, in maintaining command of the sea at strategic points, and are most useful adjuncts of such a fleet; it is held by many foreign writers that they have also a distinct field of operations. While these operations will not be decisive in their results in a war between great naval powers, yet the sudden opportune arrival of an armored cruiser, or of several of them, at well-chosen points, may have a great influence on the war. Their size, speed and armament enable them to engage successfully any except battleships. They are regarded as the most effective type for carrying on a cruiser war of depredation.

It was formerly held by some writers that armored cruisers would prove superior to battleships, owing to their greater speed, but since the close of the war with Spain such claims are seldom heard.

It is worthy of note, however, that with the effort to give increased speed to battleships and better protection to armored cruisers these two types tend to approximate.

Armored coast defense vessels appear to be practically ignored in present foreign programmes for the increase of modern fleets. There are two reasons for this, the first being the general belief that naval force will be mainly employed in sea contests, rather than in merely defending home shores against attacks by an enemy. The second reason for not building new armored coast defense vessels is that in the European navies it is felt that they already have a sufficient number of vessels of this type, and that future needs will be supplied by taking from the active armored fleet the older vessels as these are replaced from time to time by others of later type. In the British navy, in pursuance of this plan, the obsolete ships formerly stationed in home waters as coast guard and port guard ships have been succeeded by vessels which, though old, are still efficient. In Germany the same end is attained by the rule assigning a definite length of service—twenty-five years—to a battleship as such, upon the expiration of which she must be replaced by a new ship and transferred to the list of coast defense ships. The monitor type is regarded abroad as having been thoroughly discredited by the experience of the war.

The need of making liberal provision for the building of cruisers is fully recognized abroad, and this has simply been emphasized by the recent war. Their essential qualities are speed, coal endurance, and means of coaling rapidly. With these characteristics their usefulness will be so great that no admiral will be likely to feel that he has enough of them. It is generally accepted that this is as true of cruisers to-day as it was of fast frigates in the days of Nelson. Whatever method of scouting or of search be adopted, the finding of a fleet at sea must always remain a very difficult problem, in view of the obstacles of limited horizon, unfavorable weather, fog and darkness.

Very small cruisers and light draft gunboats continue to be provided, their number and varying qualities depending upon the special needs of the different navies for cruising or for minor shoal water operations.

With regard to torpedo boats and destroyers, foreign naval opinion is practically unanimous that the war has thrown no new light on the question of their value when used for the purposes for which they are intended. Navies which held them in high esteem before still continue to do so. Their vulnerability has long been recognized, as has the fact that they are peculiarly a weapon of opportunity, requiring for their successful use favorable conditions, which may or may not be present at a given time and place. Their usefulness in the training of young officers is universally conceded. Organized as instructional flotillas or as a part of the mobile defense of ports, exercises with them are continuous and systematic, and are not confined to the period of the annual manœuvres. Torpedo boat destroyers, simply larger torpedo boats with increased gun armament and better sea-going qualities, are coming more and more into favor as the best type. In Germany it has been decided to build no more small torpedo boats. New ones are to be of the destroyer class, and will be as large as the former division boats.

Foreign torpedo officers believe that while torpedo

boats are an accessory upon which dependence cannot always be placed, yet their presence will have great moral effect, and that they are capable of very effective work. In foreign squadron manœuvres night attacks by torpedo boats have very frequently been judged to be successful, and it is urged that prior to the late war the number and tonnage of vessels sunk by torpedoes exceeded those destroyed by gun fire.

Submarine boats have not received much attention abroad of late, except in France, where a number of them of new type have been authorized.

While it has not yet received embodiment to any extent in new construction, foreign comment shows a clear apprehension of the need of a sufficient number of vessels for supply and auxiliary service, having the speed and other qualities requisite for efficiency. These are seen to include colliers fitted to give coal rapidly at sea, distilling ships to replenish fresh water for boilers, repair ships to obviate withdrawal for any except for large repairs, ammunition vessels to make good the enormous expenditure of the rapid-fire guns, provision ships with refrigerating plants, telegraph cable steamers, fitted also for laying out submarine mines and for countermining operations, powerful tugs with mine-laying as well as wrecking facilities, and hospital ships.

ARMAMENT.

The view that a rapid-fire battery of moderate caliber, giving the greatest possible fire energy, should constitute the main reliance of battleships has been confirmed in the minds of foreign officers by the war with Spain. In the British navy the 6-in. rapid-fire gun continues in favor for this purpose. In all progressive navies rapid-firing guns are displacing those of older type. While a large allowance of guns of the smaller calibers is provided for special purposes, yet it is claimed by many experts abroad that in view of the abolition and removal of wood from ships, now in progress everywhere, these smaller guns will never again have the same relative importance that they had at Santiago, where it is noted that engines and boilers were not injured, steering gear was not damaged, and very few guns were dismounted. The unarmored portions of the sides of the Spanish ships simply served to explode the small projectiles, which killed and demoralized men and started uncontrollable fires. But better protection will hereafter be given, and rapid-fire guns of medium caliber will, it is claimed, become the crew-destroying weapon.

It is generally believed that future battleships will not carry any guns of larger caliber than the 12-in., and by many foreign officers this is held to be excessive. It is claimed that such guns being accessory in their nature, their fire efficiency is not at all proportionate to the sacrifices which they require. An immediate effect of the war was to reduce the caliber of the heaviest guns of the new German battleships to 9.45 in.

It is accepted that the armament of cruisers, whether armored or not, should be composed essentially if not entirely of rapid-fire guns.

Nearly all navies are endeavoring to accelerate their gun fire by improvements in mechanism and by the use of metal cartridge cases for all but the largest guns. The question of the best method of supplying ammunition, especially to meet the requirements of rapid-fire guns, is receiving earnest study abroad.

As an adjunct to the battery, various ingenious appliances, optic or electric, are in use abroad to communicate ranges and instructions to the guns. It is recognized that a hostile shell may paralyze this service, but the object will have been gained if superiority of gun fire can be achieved at the beginning of the battle.

Smokeless powder has long been considered abroad to be absolutely essential, and our recent experience has demonstrated the fact most fully. Such powder should be stable, practically without visible products of combustion, innoxious to the crew in action, and non-injurious to the bore of the gun, besides giving the requisite initial velocity. Foreign experience has shown that these qualities are difficult to obtain in satisfactory combination.

There is universal agreement abroad in the opinion that no provision should be made for the use of torpedoes by battleships and cruisers, except in underwater tubes. On this point the experience of the naval battle of Santiago has only strengthened and made more general a view which has been gathering force for several years past; a view entirely independent of any consideration of the value of the torpedo in its proper sphere. Many progressive torpedo officers, as well as others, now hold that armament with this weapon should be restricted to torpedo boats, and good arguments are offered for its abolition from cruisers and battleships. But conservatism still keeps a few on board, and new designs for battleships in the desire for a maximum of offensive and defensive power retain submerged tubes. It is argued that recent improvements practically double the effective range of the torpedo.

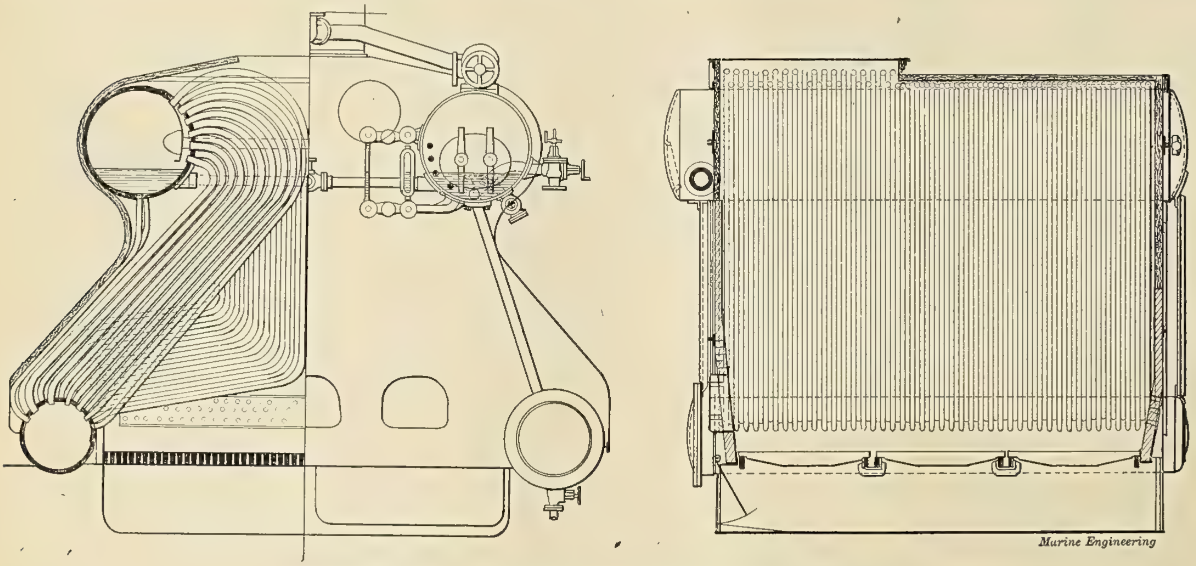
S. S. CHESAPEAKE.—The *Chesapeake*, launched by the Harlan & Hollingsworth Co., Wilmington, Del., March 3, is one of the two vessels which this company is building for the N. Y. & Baltimore Transportation Line of Philadelphia. They are intended to run "outside" between New York and Baltimore on what is familiarly known as the Shriver Line. The *Chesapeake* was christened by Miss Olivia Brengle Shriver, daughter of Clarence Shriver, president of the owning company. The dimensions of the vessel are: Length, over all, 219 ft.; between perpendiculars, 205 ft.; beam, moulded, 32 ft.; depth to upper deck at center, 23 ft. 3 in. Her motive power consists of one triple expansion, three crank, surface condensing engine of the open front type, with cylinders 18 in., 28 in., 45 in., and 30 in. stroke, supplied with steam by two Scotch boilers 11 ft. dia. and 10 ft. long. She is built of steel throughout and has two decks and three side ports on each side, and is designed to carry about 900 net tons of cargo. The load speed is about 12 knots. There are no passenger accommodations on her excepting those for the officers and crew, as the steamer is built as a freight carrier only. Her sister ship, the *Manna-Hata,* will be launched in a few weeks.

A contract has been secured by the Harlan & Hollingsworth Co., Wilmington, for the construction of a new steamer, 400 ft. long, for the Mallory Line, trading between New York and Galveston.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—IV.

Mosher Water Tube Boiler.

The Mosher water tube boiler is of the small tube variety, with expanded joints, and without any flat or stayed surfaces. It is composed of two upper steam and water drums, one at each side of the boiler, and two lower water drums, one at each side of and mostly above the level of the grate. From front to back of the boiler each pair of drums on either side is connected by rows of curved tubes. At the lower ends these tubes are connected with the upper half of the water drums with expanded ends, while at the upper ends all but two rows on each side enter the steam drums, in the upper inside segment of their circumference, above the water line. The two inner rows of tubes are bent between each other for about three-quarters of the length of the furnace thus forming the furnace crown. For the remaining to flow to the ends to start on its return to the bottom. They also prevent loss by radiation from the sides of the boiler. The upper drums are connected below the water level by a horizontal tube of large diameter, so that the entire boiler is a unit so far as water supply is concerned. The grates stop a short distance from both the front and back of the boiler. A fire brick wall is fitted at each end, and is pierced with air holes, the wall at the front having openings also at the fire doors. This protects the casing at each end of the grate, and as the holes have free communication with the ashpit the supply of air over the grate can be easily regulated by suitable dampers. Inside each steam drum a baffle plate is fitted, against which the generating tubes discharge the uprushing mixture of steam and water, the water falling to the bottom of the drum and the steam passing upward to a separator or dry pipe. A branch from the top of each drum enters a T in the front of the boiler which connects with the main steam pipe. Surface and bottom



FRONT AND SIDE ELEVATIONS OF MOSHER WATER TUBE BOILER.

ing one-quarter of the length of the furnace the tubes are staggered, allowing the gases to rise and pass upward and forward among the generating tubes on their way to the stack, which is at the front end or top of the boiler. At the back of the boiler between the upper part of the fire box and the casing a row of tubes, in a plane at right angles to the rows of generating tubes, also connects each pair of drums at each side. These latter tubes form a protecting wall at this point and at the same time are an efficient part of the generating system. At each side of the boiler just inside the casing there is a double row of down flow tubes extending from back to front and connecting the bottoms of the drums on top with the water drums at the bottom. These tubes are of the same diameter as the tubes forming the generating system. They are farthest removed from the action of the gases and are comparatively cool. By the use of these tubes, instead of outside down flow pipes of large diameter, greater compactness is claimed as well as a direct circulation from generating to down flow tubes the entire length of the boiler, the water not having to flow to the ends to start on its return to the bottom.

blows are fitted, and all the usual attachments in conformity with first-class modern practice. This boiler has been used extensively where hard service is demanded. The designer has fitted it in a number of fast pleasure boats, such as *Yankee Doodle, Nada, Feiseen, Norwood* and *Ellide*. It has been installed also in several torpedo boats of the U. S. Navy, and has been adopted for several of the new war vessels now under construction. It is built by Charles D. Mosher, 1 Broadway, New York.

New Timber Floating Dock.—Extensive additions to the facilities of the Morse Iron Works and Dry Dock Co., foot of 26th St., Brooklyn, New York, have been arranged for. These will include a new sectional floating dock of sufficient capacity to accommodate the largest vessels afloat. The dock will be constructed of yellow pine lumber and will be 800 ft. long over all. Each section will be 80 ft. long by 120 ft. wide, and the pontoons will be 15 ft. deep. The dock will be equipped with centrifugal pumps, driven by electric motors, and with other up-to-date apparatus.

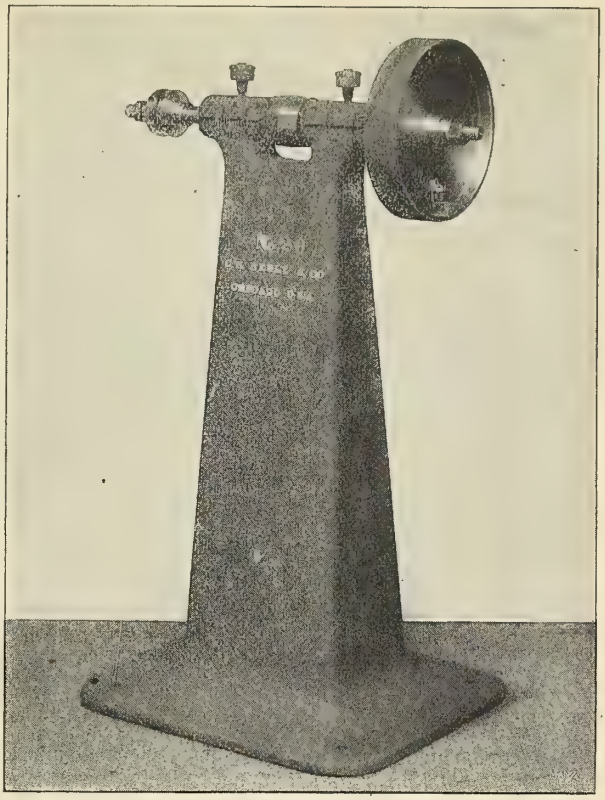
IMPROVED APPARATUS.

Standard Pneumatic Tools.

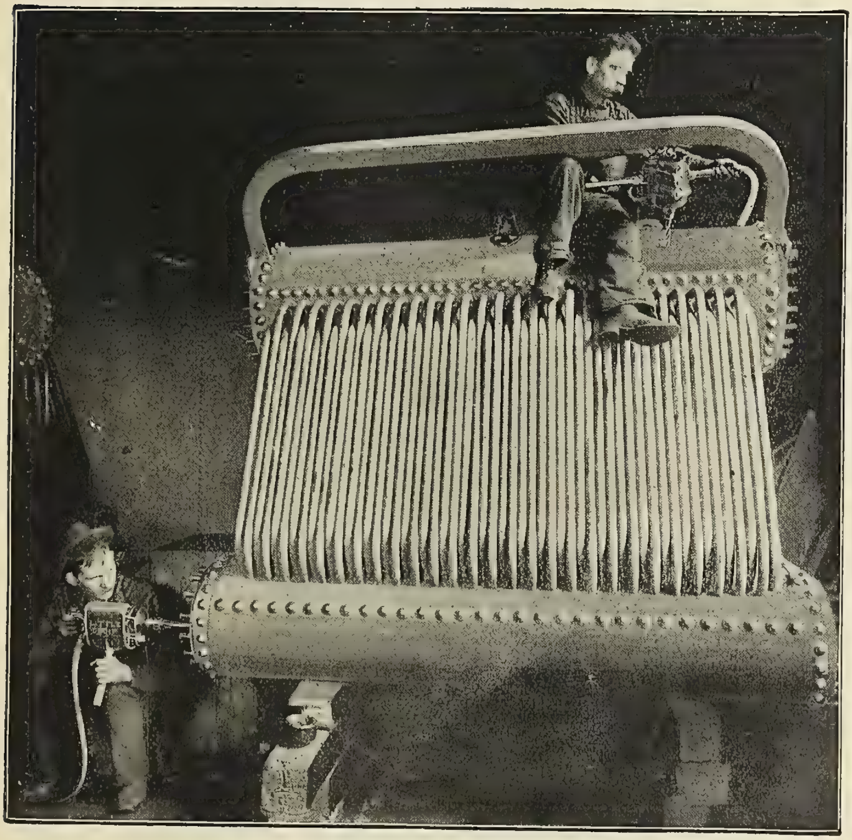
The accompanying illustration shows the "Little Giant" pneumatic reversible flue rolling, reaming and tapping machine, which the Standard Pneumatic Tool Company, of Chicago, has recently placed on the market for various classes of work. It is especially designed to fulfill the requirements of shipbuilders and other affiliated lines, being simple in construction, light in weight and very economical in the consumption of air, and capable of rolling flues up to 4 in. and reaming and tapping up to 1 3-4 in. It is of the piston type, and has double-balanced piston valves which cut off at 5-8 of full stroke. Is made entirely of steel and is geared to run at a high rate of speed, and can be reversed running at full speed by simply turning the grip handle to the right or left, no gears being used to accomplish this change of motion. The makers state that this machine has been given thorough and exhaustive tests in a number of shipyards, and the results have been highly satisfactory, one machine being capable of performing the work of five men. The company offers it to anyone on trial who is desirous of testing his efficiency. The company's address is Marquette Building, Chicago, Ill.

Besly Band Grinder.

We illustrate herewith the Besly band grinding machine. The complete machine consists of pedestal, as shown, countershaft and spindles to hold either one or two emery band polishing wheels. These wheels are made of cast iron. An elastic surface is produced by a felt covering. The emery, or other abrasive material, is a piece of emery cloth which is tightened firmly around the wheel. To reset the wheel, or change the grade of emery, it is necessary only to remove a band and replace it with another, an operation requiring only a minute of time. One of these wheels will take the place and do the work of a large number of polishing wheels. The wheels when used with emery bands are always perfectly balanced and ready for use. This machine is suitable for shops where skilled polishers are not employed. An ordinary shop boy with a little practice can do the work. The diameter of the wheel is 12 in., and the width of face 2 1-2 in. The machine is made in a variety of combinations, so that, in some cases, the band wheel can be used at one end and an ordinary buff or emery wheel at the other. The makers are Chas. H. Besly & Co., 12 North Canal street, Chicago, Ill.



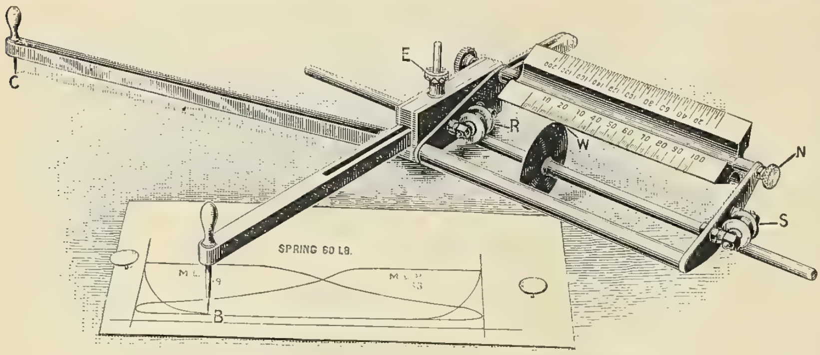
BESLY BAND GRINDER.



LITTLE GIANT PNEUMATIC TOOLS IN USE.

Improved Willis Planimeter.

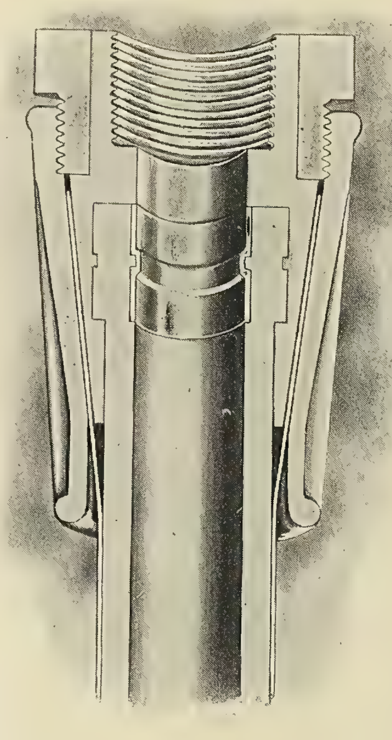
We show in our illustration the improved Willis planimeter, which is especially designed for the calculation of indicator cards. Users of the former instrument with the glass rod will note that in the new form the glass rod is replaced by a polished steel spindle, which glides beneath the two rollers *R* and *S*. This gives the instrument great smoothness and accuracy of wheel movement, as well as rendering it thoroughly substantial and durable. The depressible pin *E* avoids the trouble of turning the instrument over when setting to card length. The removal of the milled head screws permits the instrument to be taken to pieces and packed readily in a small leather covered case 1 1-2 in. by 3 1-2 in. by 9 1-2 in., which can be carried in the pocket or in an indicator box. The white enameled triangular scale has six graduated edges, and by turning the proper one next the wheel the mean effective pressure can be read directly from the card without calculation. The same scale can be used for setting for boiler pressure, vacuum lines, etc. The instrument is not only serviceable for measuring indicator cards, but, by reason of its various scales and adjustable arm length, will read areas directly in square inches or directly in units particularly suited to draughtsmen and engineers, such as square feet, square yards on different scale drawings, acres on survey maps, etc. There can also be purchased with the instrument a horse-power attachment which permits horse-power to be read directly from indicator cards without calculation of any kind. This latter will be especially appreciated by engineers who have many cards to calculate or to report the horse-power regularly. The instrument is made of polished brass and steel, fully nickeled, and presents a pleasing and attractive appearance. It is manufactured and sold by Jas. L. Robertson & Sons, 204 Fulton street, New York, N. Y.



WILLIS PLANIMETER MEASURING INDICATOR DIAGRAMS.

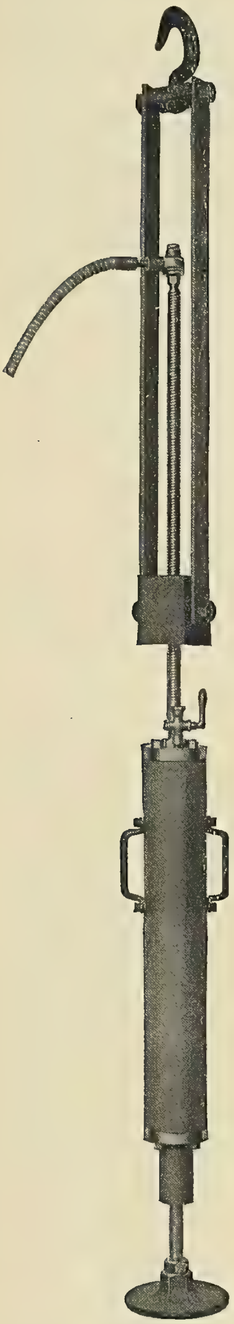
Climax Armor Hose Coupling.

In these days of extensive use of pneumatic tools in shipyards the item of cost of flexible hose becomes a serious one. Various forms of protective coverings for hose have been tried, with very often unsatisfactory results, due to the imperfect method of attachment to the couplings. The accompanying engraving shows a section of the climax armor hose coupling for use in connection with hose armor consisting of interlaced spiral metallic bands. To apply this coupling to the hose the latter is inserted in the brass sleeve until it butts on the collar below the internal screw. A brass ferrule is then inserted in the end of the hose and expanded, so as to spread both the ferrule and the hose end into the recess cast in the sleeve. Afterward, when the coupling is complete and put in service, it will be seen that the tendency of the air pressure is to make this connection tighter. After the hose end is secured, the armor is pulled up over the tapered end of the sleeve and the outside cover pushed up over it, until it engages the nut at the top. By screwing in this nut the pressure of the outside cover on the metallic armor is increased, so that it is impossible for the armor to work loose. It will be noticed that the lower end of the outside cover is rounded off, so that there is no tendency to kink the hose when a sharp corner is turned near the coupling. The entire coupling is made of the best brass composition, and is practically indestructible. The armor used in connection with this coupling possesses the durability of steel, with the flexibility of India rubber, and prevents bursting, kinking, cutting and mashing of the hose, and will withstand a pressure of 1,000 lb. A large number of these couplings have been put in service with very satisfactory results. They are manufactured by F. G. Street, 538 Temple Court Building, Chicago, Ill.


CLIMAX ARMOR HOSE COUPLING.

Keller Pneumatic Rammer.

Hitherto the use of pneumatic tools has been chiefly in ship work and in the machine shop. Now, however, that the advantages of compressed air have come to be better understood its services are being extended to other departments. A valuable time and labor saving aid in the foundry is the pneumatic rammer, the type known as the Keller rammer being here illustrated. This machine is made in three sizes, and is designed for use in heavy loam work and other moulds of large size. One man with the aid of this rammer can do as much work as would formerly have required the services of eight or twelve men by the antiquated hand method. In use the rammer is suspended at a convenient point and is easily moved about over the work by the operator. The rammer piston is controlled by a valve similar to that employed in pneumatic chipping hammers, and the machine is started, stopped and regulated by a special throttle valve which forms a part of it. The advantage in the use of a pneumatic rammer in the foundry lies not only in the rapidity, but in the absolute uniformity of the work, all blows being struck with the same force. This precludes the possibility of hard and soft spots in the mould, with the corresponding defects in the castings, and produces moulds much more compact than is possible by hand labor. The manufacturers will send any of their tools to responsible parties on ten days' trial, subject to approval, and all their tools are guaranteed against cost for repairs for one year. Their address is Philadelphia Pneumatic Tool Co., Stephen Girard Building, Philadelphia, Pa.



KELLER RAMMER.

As the result of experiments with the Marconi system of wireless telegraphy on the North German Lloyd liner *Kaiser Wilhelm der Grosse*, it is probable that this method of communication will be adopted on all the fast ships of that line. Signals were exchanged between the liner and a station 50 miles distant.

LAUNCHES—HOME AND FOREIGN.

Tug William J. Bradley.—The tug *William J Bradley* was launched from the yard of the American Dredging Co., Camden, N. J., March 13. Her dimensions are: Length, 85 ft.; beam, 19 ft. 6 in.; depth, 10 ft. A compound engine 14 in. and 40 in. by 20 in. is fitted. The cost of the tug is about $20,000.

S. Y. Florence.—At the yard of the Herreshoff Mfg. Co., Bristol, R. I., the S. Y. *Florence* was launched March 19. She is a schooner rigged vessel, 110 ft. long, built to the order of A. H. Alker, of New York. She will be fitted with engines constructed by the builders, and is expected to have a cruising speed of about 14 knots.

S. S. Northumberland.—The passenger and freight S. S. *Northumberland* was launched by the Neafie & Levy Ship & Engine Building Co., Philadelphia, March 3. This vessel was built for the Weems Steamboat Co., of Baltimore, Md., for service on the Chesapeake Bay. She is fitted with a triple expansion engine, with cylinders 18 in., 28 in. and 45 in. dia. and 30 in. stroke, of about 1,100 I. H. P., and two Scotch boilers. About 60 staterooms will be fitted.

Sch. Helen W. Martin.—A 5-masted schooner, the *Helen W Martin*, was launched from the yard of Percy & Small, Bath, Me., last month. Her dimensions are: Length, 280 ft.; beam, 44 ft.; depth, 20 ft.; gross tonnage, 2,265 tons. Oak is the material used in construction of the hull. A steam plant for handling the vessel includes a Hyde steam windlass, wrecking pumps, deck hoisters and donkey boiler. The vessel's lower masts are 118 ft. high and topmasts 54 ft. The standing rigging is steel wire set up with turnbuckles. The vessel is for the coasting or foreign trade.

S.S. Orlando M. Poe.—The lake freight steamer, *Orlando M Poe*, was launched from the Globe yard at Cleveland on March 1. The new vessel, which will be added to the Bessemer fleet, is of these dimensions: Length on keel, 475 ft.; beam, 50 ft.; depth, 29 ft. She is fitted with a single screw and quadruple expansion engines, with cylinders, 26 1-2 in., 37 in., 54 1-2 in. and 80 in. by 42 in. stroke. Steam is supplied by four cylindrical boilers, 13 ft. 4 in. dia. and 12 ft. 3 in. long, built for 200 lb. working pressure. The vessel will carry 6,900 gross tons on 18 ft. draft. She was christened by Miss M. Miner.

S. M. S. Prinz Heinrich.—At Kiel dockyard the German armored cruiser *Prinz Heinrich* was launched March 22. Her dimensions are: Length, 393 ft.; beam, 65 ft.; draft, 24 ft.; displacement, 8,800 tons. Triple expansion engines of 15,000 collective horse power will be fitted for driving the twin screws, and a maximum speed of 20 knots is expected. Guns of the Krupp system will constitute the armament, ranging in number and size from two 9.45-in. downward. Armor carried will be of varying thickness from 5.9 in. on the revolving turrets to 3.9 in. on the gun positions. This vessel is of the same type and much the same size as the U. S. S. *New York*. She was christened by Princess Henry of Prussia.

MARINE ENGINEERING

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SECRETARY of the Navy John D. Long recently issued a general order creating a board of officers with functions which, in part, are apparently in conflict with those of several of the existing naval bureaus. The order reads as follows:

General Order No. 544—A General Board is hereby established to be composed of the following officers: The Admiral of the Navy, the Chief of the Bureau of Navigation, the Chief Intelligence Officer and his principal assistant, the President of the Naval War College and his principal assistant, and three other officers of or above the grade of Lieutenant-Commander. Should the principal assistant of the Chief Intelligence Officer, or the principal assistant of the President of the Naval War College, be below the rank of Lieutenant-Commander, an officer or officers of the grade of Lieutenant-Commander or above will be designated to fill such place or places on the board. The purpose of the Department in establishing this board is to insure efficient preparation of the fleet in case of war and for the naval defence of the coast. The Chief of the Bureau of Navigation will be the custodian of the plans of campaign and war preparations. He will indicate to the War College and Intelligence Office the information required from them by the General Board, and in the absence of the Admiral of the Navy he will preside at the meeting of the board and exercise the functions of President of the Board. The board will meet at least once a month, five of its members constituting a quorum, and two of its sessions every year shall extend over a period of not less than one week each, during which time the board shall meet daily.

It will be seen that the naval officers specifically designated by the order include those whose duties are such as to fit them especially for the discussion of questions of strategy and tactics. Subsequent to the publication of the order the three additional officers were increased to five, the selections being Captain Robley D. Evans, Captain Henry C. Taylor, Captain Charles E. Clark, Captain French E. Chadwick and Colonel George C. Reid, U. S. Marine Corps. All the naval officers who are members of the board, therefore, will be combatant officers pure and simple; officers who have always been in the line and who, therefore, have not been transferred thereto. This must indeed be a surprise to those who in advocating the recently enacted personnel bill, saw in that measure a full and free recognition on the part of the old line of the importance of exact engineering knowledge in modern naval operations. Now that line and staff are amalgamated, and are on equal footing as regards rank and privileges, the absence of officers possessing expert engineering knowledge from the board cannot have been occasioned by the spirit of antagonism which existed between the line and the old engineer corps. It must, therefore, be set down to a decision—uninfluenced by any strife—on the part of the powers that be, that the training of the sailor is the best preparation for those to whom is intrusted "the efficient preparation of the fleet in case of war," and for the naval defense of the coast. To many this position will not come as a surprise, for they have looked in vain in past discussions for any admission from the genuine dyed-in-the-wool line that the future naval officer is to be the fighting engineer, but have expected rather that engineering duties afloat would be relegated slowly, though most certainly, to the enlisted man. Now as to the composition of the board: Were its duties only such as would relate to the fighting of ships there might be some grounds for excuse for excluding engineering knowledge from its membership, it being assumed that such knowledge, if necessary, would be obtainable as outside advice. But in this case one of the specific duties of the board is "to insure the efficient preparation of the fleet in case of war," and, manifestly, such duties can only be efficiently performed by a membership which contains a proper balance of engineering science. Without such knowledge the board could only carry on

its duties at second hand, trusting not to personal observation, but to the reports of other and skilled persons. What would have been thought in the old sailing days of a board, with similar duties, which would not have included in its membership a single person who had any intimate acquaintance with sails, or rigging, or spars? About the only explanation that would explain is: "That's the way we do it in the Navy." Can anyone picture the management of the American, the Cunard, or the North German Lloyd lines appointing a board of sea captains to insure the "efficient preparation" of their fleets in case such were needed for service. We rather think that an official styled the superintending engineer would in each instance occupy a large-sized chair near the head of the table in the consultation room. That would be "the way it is done in the merchant marine." Were the duties of such a naval board of a strictly military character, preparation of plans of offense and defense, its existence and composition would be much better understood. To charge it, however, with duties which should now be discharged by existing bureaus, and at the same time to exclude from its membership those who could give it strength and purposefulness, appears to be the best possible way to create confusion and conflict, which would result in disorganization if not disaster in time of emergency. It is apparent that the same influences which secured the appointment of a board of deck officers for the investigation of the *Maine* disaster are still successfully active. For our own part we believe that a condition of "efficient preparation" of our fleets would be better secured by the cultivation of more officers of the Robert W. Milligan type than by the establishment of a score of "general boards."

IN Congress the House Committee has decided upon a naval shipbuilding programme for 1900, which contemplates the construction of two first-class battleships to cost about $3,600,000 each; two first-class armored cruisers to cost about $4,000,000 each; and three protected cruisers to cost about $1,140,000 each. A sum of $12,000,000 is appropriated for the carrying on of construction work on ships already authorized, and additional to this $250,000 for equipment. Progress is made in the long disputed matter of armor plate, the appropriation bill containing a provision authorizing the Secretary of the Navy to contract for armor at the price of $540 a ton. No limitations are imposed as to the total amount of armor to be contracted for at this price, but the expenditure during the coming fiscal year is limited to $4,000,000. By this it is understood that the committee contemplated the letting of contracts only for armor necessary to complete the battleships *Maine, Missouri* and *Ohio* now building. In the bill provision is also made for the construction of two new dry docks, one at the Brooklyn (N. Y.) Navy Yard, and one at the Portsmouth (Va.) Navy Yard, to be of the largest capacity and to cost $1,200,000 each. For continuing the work of rebuilding the Naval Academy at Annapolis $600,000 is appropriated, and a further sum of $2,500,000 for the construction of new cadet's quarters. The question of sheathing ships is left to the discretion of the Secretary of the Navy for settlement, and there is no special provision in the bill for the construction of warships in U. S. navy yards. The provisions of the bill do not in all cases represent the views of the entire committee, and it is not unlikely that there will be prolonged discussion in the House when the bill comes up. In the case of the provision for armor plate the decision was only reached in committee by a majority of two. Meanwhile the Naval Board on Construction, in the expectation that the armor plate dispute would be settled in favor of the Krupp plates, has gone ahead with the discussion of plans for the building of the three battleships and three armored cruisers provided for in the programme of a year ago. Tank experiments with models of the proposed battleships have been in progress for some time at the Washington Navy Yard, and it is reported that these have shown that a considerable addition will have to be made to the displacement of these vessels to carry the armament provided and the machinery necessary to secure the sea speed of 18 knots. New dimensions suggested are: Length, 435 ft.; beam, 75 ft.; with a displacement of 15,000 tons. A preliminary statement for the information of intending bidders is to be issued shortly. The armored cruisers are to be of about 14,500 tons displacement, and are to have a sea speed of 22 knots. Four 8-in. guns in two turrets and a large number of 6-in. rapid firers in broadside will constitute the main batteries. A circular giving the general characteristics of these cruisers will be issued later. The programmes of 1899 and 1900 would give a much needed and effective increase to our Navy.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—VI.

BY DR. WILLIAM FREDERICK DURAND.

§4. BOILER SCALE.

It is well known that sea water contains in solution a certain amount of solid matter, while even ordinary fresh water is not wholly free from similar substances. As long as the water remains in its natural condition these solids remain in solution; but under the change of condition to which the water in a steam boiler is subjected, they are liable, as explained later in detail, to separate out from the water and thus to form scale or sludge according as the circumstances may determine.

The proportion of the solid matter in ordinary sea water is about (by weight) 1 part in 32, or 1-32. This is the same as about 5 oz. per gallon, or 2 lbs. per cu. ft. The solid matter consists chiefly of chloride of sodium or common salt with small quantities of calcium sulphate and carbonate, magnesium sulphate and chloride, with smaller quantities of other substances. An average composition of this solid matter is about as follows:

Chloride of Sodium (common salt)	76	per cent.
Chloride of Magnesium	10	"
Sulphate of Magnesium	6	"
Sulphate of Calcium, (gypsum)	5	"

The remaining 3 per cent. consists of small quantities of other salts with a little organic matter.

The proportion of solid matter in river and lake water is quite variable with the locality, and no representative or average analysis can be given. The amount held in solution may vary from perhaps 10 to 250 parts in 100,000 or from .015 oz. to .30 oz. per gallon, or .1 oz. to 2.5 oz. per cu. ft. It is composed chiefly of the carbonates of calcium and magnesium with smaller quantities of the sulphates of calcium and magnesium, and other substances. In addition to the substances in solution, quantities of sand, mud, organic matter, etc., may be carried in suspension, dependent entirely on the locality and special circumstances.

Boiler scale from sea water is composed chiefly of calcium sulphate or sulphate of lime, as it is commonly called, while that from fresh river or lake water is composed chiefly of calcium carbonate or carbonate of lime as commonly called. With brackish water, as we might expect, the proportions of the two are more nearly the same. Following are analyses of boiler scale by Prof. Lewes which may be considered as typical of the incrustations formed by river water, brackish water, and sea water, respectively.

CONSTITUENTS.	RIVER.	BRACKISH.	SEA.
Calcium Carbonate	75.85	43.65	0.97
Calcium Sulphate	3.68	34.78	85.53
Magnesium Hydrate	2.56	4.34	3.39
Sodium Chloride	0.45	0.56	2.79
Silica	7.66	7.52	1.10
Oxides of Iron and Alumina	2.96	3.44	0.32
Organic Matter	3.64	1.55	trace
Moisture	3.20	4.16	5.90
	100.00	100.00	100.00

It thus appears that scale from river water may be looked on as an impure calcium carbonate, that from sea water as an impure calcium sulphate, while that from brackish water, as we should expect, is a mixture of the two in more nearly equal proportions.

Sodium chloride or common salt is soluble in water until the proportion exceeds some 25 or 30 per cent. This corresponds to a density of 8 or 10 on the usual hydrometer, and is far greater than that reached by the water in marine boilers. This substance therefore gives no trouble so far as helping to form scale is concerned, and the small amount found in analyses of boiler scale is probably due to the shutting in, so to speak, of a small amount of water during the formation of the scale. In discussing the formation of boiler scale for our present purposes, it will be sufficient to refer to the behavior of the salts of calcium and magnesium.

Calcium carbonate ($CaCO_3$) is practically insoluble in water, while calcium bicarbonate (CaC_2O_5) is quite soluble, and it is in this form that the substance exists in solution in water. If now the water is heated to the boiling point carbonic acid (CO_2) is driven away from the bicarbonate, it becomes reduced to the simple carbonate, and being now insoluble it separates out as a more or less powdery deposit. Mixed with other salts, however, especially calcium sulphate or if there is a little sulphuric acid in the water, it may collect on the heating surfaces and form a hard and closely adhering scale. Magnesium bicarbonate is in a similar manner reduced to the simple carbonate, which is insoluble and is then deposited in the same fashion.

Calcium sulphate is soluble in cold water to a slight extent, as found in sea water. As the water is heated, however, or as the density becomes greater, the proportion of sulphate which it can retain in solution becomes less and less. When the temperature rises to from 280° to 290° (corresponding to from 35 to 45 lbs. gauge pressure) the water can no longer retain any of the sulphate in solution, and it is all deposited. It is also entirely deposited, even at a temperature of 212°, if the density rises to 3-32 or above. The other sulphates become likewise insoluble and are completely deposited if the temperature rises to about 350° or over, corresponding to about 120 lbs. gauge pressure. These sulphates of lime and magnesium thus deposited tend to attach themselves to the surfaces within the boiler, and to form a very hard and crystalline scale.

As to the effects of this scale, its presence in a *very thin* layer is often considered beneficial as a protection to the surface of the boiler from corrosive influences. On the other hand, however, it is a much poorer conductor of heat than metal, and its presence on the heating surfaces retards the transmission of heat from the fire through to the water. In the extreme case the heat may be so effectually shut off from the water that it simply becomes banked up, so to speak, in the metal, and in this way the tubes and other heating surfaces may become seriously overheated with resulting damage to the boiler. The scale may also in extreme cases become so collected between the tubes or between the combustion chamber and boiler sheets as to impede the circulation of the water and thus lead to overheating and its dangers as referred to above. In water-tube boilers the accumulation of scale on the inside of the heating tubes is of special danger, as the circulation becomes in such case rapidly obstructed and the danger of overheating and rupture is correspondingly increased. In a similar man-

ner the accumulation of scale in the interior of tubular feed-water heaters rapidly decreases their efficiency as heaters, if no worse results follow due to the burning out of coils, or to the resulting shortness of water in the boilers.

Scale Prevention, Fresh Water—The only sure way of preventing scale is simply to keep it out of the boiler. If the scale forming substances find entrance to the boiler it will be found very difficult to prevent its formation, at least to some extent.

On boats navigating inland waters the jet condenser is still for the most part used, and the feed is ordinarily taken from the condenser, and therefore practically from overboard. In such boilers, therefore, we may expect the formation of the usual fresh water scale, consisting chiefly of calcium carbonate. For the treatment of fresh water scale a great variety of methods have been proposed. In some cases the substances proposed act chemically, in others mechanically. From the great variation in the character of the solid matter contained in fresh water, it can hardly be expected that any one method of treatment or substance will prove equally good in all cases.

If a feed-water heater is used, and is effective in heating the water, it will be found that most of the scale will be deposited in the heater, especially if it is of sufficient size to allow of proper time. In this way the scale may be kept out of the boiler proper. The heater, however, should be so made as to readily admit of cleaning, especially if the water contains any considerable proportion of scale forming salts, otherwise it will soon become choked and ineffective.

Among the various substances which have been recommended for the prevention of fresh water scale the following may be mentioned.

Oak and hemlock bark and other like substances which contain tannic acid are more or less effective in waters containing carbonates of calcium or magnesium. The tannic acid, however, will attack the iron of the boiler and may lead to serious corrosion.

Molasses, cane juice, fruits, distillery slops, vinegar and other like substances containing acetic acid have also been used with success where no sulphates are present. The acetic acid, however, is still more injurious to the iron than the tannic acid, and the organic substances will form a scale with sulphates if they are present.

Sal-ammoniac when used with a feed water containing calcium carbonate brings about an exchange between the two substances as a result of which ammonium carbonate and calcium chloride are formed. The former of these is soluble and quite volatile and passes off mostly with the steam. The latter is quite soluble and thus the deposition of the calcium carbonate is avoided. This operation by itself, however, would result in the gradual accumulation of calcium chloride in the boiler, thus raising the density of the water to a point where ultimately it would begin to deposit. This condition may, of course, be controlled by a suitable use of the blow.

Tannate of soda is well recommended for general use, but with water containing sulphates a small amount of soda-ash should be added.

Among the substances which act mechanically, crude petroleum and kerosene oils are probably the most widely used. The latter may be recommended as the better of the two, as the crude oil will sometimes aid in scale formation. They seem to act best in cases where there are some sulphates present, as in slightly brackish water, or in the waters of certain geographical regions. Kerosene seems to act by preventing the particles of scale from sticking closely together or from tightly adhering to the heating surfaces, so that much of the matter will collect as a sludge in the bottom of the boiler, and that on the heating surfaces will be more easily removed.

In all cases where there is reason to expect the accumulation in the bottom of the boiler of deposits thrown down in a loose or powdery form, the bottom blow should be freely used so as to prevent the accumulation of too great a quantity, or opportunity for its hardening into scale.

In spite of all modes of treatment there will be found some scale on the heating surfaces, and provision must be made for entering the boiler and removing it with appropriate tools as the occasion demands and circumstances permit.

In many of our inland waters the amount of scale forming substances is so small that no special treatment is thought necessary, and little attention is paid to the matter except to remove the accumulation at the periods of regular inspection and overhaul.

ENGINEERS' DICTIONARY.—XXVI.

Lead—The amount by which a valve port is open when the engine is on the center, or piston at the end of the stroke. See Fig. 85, where *AB* on the steam side

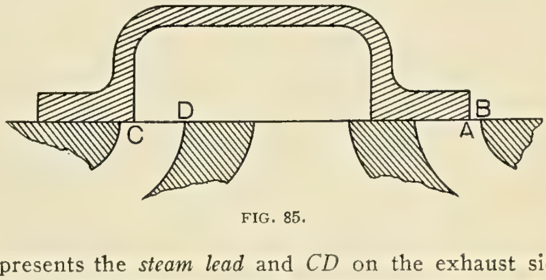


FIG. 85.

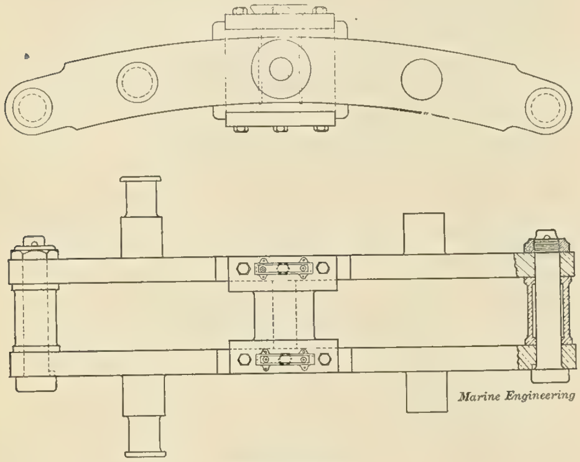
represents the *steam lead* and *CD* on the exhaust side represents the exhaust lead, the engine being supposedly on the center for this position of the valve.

Liner—In general, a piece of metal intended to take the wear of working parts, or to fill in between the parts of a bearing so as to allow of an adjustment. Thus the main cylinder barrels and valve seats are often provided with a working liner. See under *Cylinder*, Fig. 42. Likewise between the two parts of the main pillow blocks or other similar bearings, there is placed one or more metal strips or liners, thus providing for adjustment as the parts of the bearing become worn and require taking up.

Line Up—A term signifying the adjustment of an engine or line of shafting so that all parts shall be in line, or in the same plane, or at right angles to the center line, as may be required for smooth and proper working. Thus when a marine engine is properly *lined up* the shaft bearings from propeller to main pillow-blocks are all accurately in line; the piston-rods all move in the same plane, and the line of motion of each is perpendicular to the axis of the shaft; and similarly for all moving parts.

Link—In its more general sense a link is a rigid moving part of a machine serving to transmit motion from one piece to another. Thus in the mechanism forming a steam engine the connecting rod is a *link*. The rods which connect the end of the air pump lever to the air pump cross-head are *links*, etc.

In its more particular sense the term link usually refers to a part of a valve gear, as in Figs. 86 and 87, showing the Stephenson link. The form commonly met with in modern practice, and as shown in the figure, is known as the double bar link. This consists of a pair of bars curved in the arc of a circle of radius



FIGS. 86 AND 87.

equal to the geometrical length of the eccentric rod; that is, equal to the distance from the center line of the link to the center of the eccentric sheave. These bars are connected at the ends by bolts, as shown, with distance pieces between them. Near the ends are fitted the pins which serve for connecting with the eccentric rods as shown. Another pair of pins is also fitted either at the center or as an extension of the pins at one end, or at some intermediate point. To these are attached a pair of links usually known as *side* or *bridle* rods. These lead to the *rock* or *weigh* shaft, and serve to control the position of the link and thus to vary the point of cut-off, according to the principles which govern the action of this form of valve gear.

Between the two bars of the link is the *link block*. This consists of a central pin, with wing pieces at the ends, the latter being fitted with bearing surfaces for connecting with the bars of the link, and permitting sliding motion between the two. The pin is connected with the lower end of the valve stem by an appropriate bearing, and thus the motion of that part of the link where the block is located is transmitted to the valve in accordance with the mode of operation of this type of gear.

The single bar link consists of a single curved bar, with a slot of corresponding curvature, carrying a block and operating essentially as for the double-bar link.

Link Block—See *Link*.

Link Motion—A general term for an assemblage of links forming a mechanism; or, more particularly, for a Stephenson link valve-gear taken as a whole.

TECHNICAL PUBLICATIONS.

ELECTRIC WIRING. By Cecil P. Poole. First Edition, 1900. Power Publishing Co., New York. Size, 4 1-2 by 6 3-4. Pages, 101. With many diagrams. Leather cover, $1.00.

This book is the only one thus far published in which actually complete data and instructions are given for the laying-out and computation of circuit wires for all classes of service. The scope of the book extends from the simplest motor wiring to the most complex polyphase alternating-current circuits, including three-wire direct-current circuits, etc.

Not only instructions and rules are given, but there are diagrams illustrating these and comprehensive tables, calculated from them. The tables will enable any-one, without technical education, to determine the proper sizes of wire for any class of service, and the arrangement is such that much greater accuracy may be obtained and finer distinctions may be drawn than from the usual form of wiring table. One immensely valuable feature is a set of tables for two-wire and three-wire direct-current circuits and two-wire alternating-current circuits, which enable the user to determine, at a single operation, the sizes of wire to use in both the feeder and the mains of the system, for a given "drop" over all.

Besides the tables and wiring instructions, there are several pages of diagrams showing the various methods now in vogue of connecting up bells, lamps, transformers and motors, and an appendix containing complete formulas for all wiring computations.

An advantage of the book is its most convenient size—practically a pocket-book. It is very well printed and neatly bound in a flexible leather cover. For the engineer who has the laying out of electrical work, as well as for the out and out electrician, the book is without qualification an indispensable assistant.

MARINE ALMANACK, 1900. Edited by *Mittheilungen aus dem Gebiete des Seewesens*. Gerold & Co., publishers, Vienna, Austria. Pocket size. Pages 435. With marginal index, blank sheets for notes and pencil case; and many illustrations. Price, 4 1-2 marks.

The purpose of this little volume is to furnish in condensed form the greatest possible amount of information relating to the navies of the world and their armaments. Prepared fundamentally under the auspices of the Austrian Department of Marine, and for German-speaking peoples, its reputation and field of usefulness have become widely extended as a reliable, compact and convenient source of information on the subjects of which it treats.

Aside from the calender and like information of general interest, the book is divided into four parts.

Part I consists of reduction tables for weights and measures. This covers some 30 pages of closely printed matter, and gives, in most convenient form, conversion tables for all sorts of measures, but chiefly, of course, between the English and metric systems.

In part II is given an abstract of marine international law. This is divided into three parts: that relating to peace, that relating to war, and sea ceremonial. The subject matter is arranged with suitable catch heads, and in condensed and convenient form for reference.

The purpose of the compiler has been to state in the briefest possible way the accepted conventions of international law as they bear on maritime matters, and he is to be congratulated on having produced so complete and convenient a condensation of so wide a subject.

Part III is devoted to tabular data relating to naval ordnance. It covers some 70 pages of matter, and gives in great detail the leading features of the naval ordnance of all maritime powers.

In part IV is presented in tabular form a collection of the leading particulars of the various ships belonging to all naval powers. This covers about 150 pages, and is followed by over 100 pages of line engravings, showing the general appearance of representative ships of the various navies, with diagrammatic representations of the character and distribution of the armor and main battery. Following this and concluding the book is a single alphabetical list of the names of all ships described.

The information relative to ordnance and ships is, of course, similar in character and arrangement to that given in the larger English Brassey, and, while the latter is fuller in some details, the present volume shows how much may be gotten into a volume of pocket size by condensation with suitable abbreviations and arrangement of matter.

The data and measures are, of course, all in the metric system, but the conversion tables above referred to make their change into English measures a comparatively simple matter.

MARINE TECHNICAL DICTIONARY, GERMAN, ITALIAN, FRENCH and ENGLISH Supplement to Vol. I. By Captain Julius Heinz. Published under the editorial direction of *Mittheilungen aus dem Gebiete des Seewesens*, Pola, Austria. Gerold & Co., Vienna, or Dulau & Co., 37 Soho Square, London, W. Size, 6 1-2 by 9 1-2. Pages, 867. No illustrations. Cloth.

About seventeen years ago there appeared the first volume of a nautical-technical dictionary, designed on the broadest and most comprehensive plans. Its author, M. P. E. Dabovich, was occupied some twenty-five years on its compilation, and the first volume was seven years in printing, finally appearing in 1883. It appears that adverse circumstances have until recently prevented the continuation of this work. A few years since, however, the Austrian Minister of Marine ordered the completion of the dictionary, and such progress has been made as to render possible the renewed publication of the work. The first issue is the subject of this notice, and is a supplement to the first volume referred to above. The author of this supplement has adopted the same general methods and lines of work as in the original publication, in order that by the aid of this supplementary volume the part previously published may be brought fully up to date, and made completely representative of the present state of technical marine terminology.

The supplementary volume thus planned contains a double vocabulary of German and Italian words in an alphabetical order, the former in roman and the latter in *italic* letters, to distinguish more readily between them. When the leading word is German it is followed by its equivalent in Italian, French and English in order, and when the leading word is Italian it is followed by its equivalents in German, French and English in order For translation into English the work is, therefore, equivalent to two dictionaries, one Italian into English and one German into English. The terms given are, with few exceptions not described or defined, and when such is the case only for the German or Italian reader. The work is, therefore, a dictionary simply in the sense of a collection of equivalents in the four languages mentioned, and is, therefore, intended for use in translating from one language to another rather than for purposes of description or definition. The field covered by the work includes not only subjects strictly related to marine construction, navigation, naval warfare, etc., but comprises also all related branches of science and art such as electro-technics, astronomy, chemistry, mathematics, etc. In addition to single words or objects briefly described, a great variety of objects requiring long descriptive phrases are included, such, for example, as "Screw generated by a right line making an angle with the axis backward."

As a departure from the usual mode of presentation, the entire subject matter relating to the torpedo is collected in order under that one head, forming a special vocabulary by itself, and similarly for a few other subjects.

While modern marine terminology is thus exhaustively represented in the present work, it is but a supplement to an earlier volume. It is, therefore, not complete in itself, but abounds in references to the original Vol. I. This, unfortunately, will detract much from its use to those who may not have at hand the earlier volume referred to.

A criticism may, perhaps, be also made on many of the words introduced as being quite untechnical and better left to the ordinary dictionary. Among many illustrations mention may be made of the words *obelisk, reference, crisis,* and expressions such as *damage caused by fire* and *to cross a river.*

The translations into English seem in general to have been made with great care and accuracy, while the extent of the work as a whole and its exhaustive presentation of modern marine terminology are such as to place it easily at the head of such technical dictionaries.

An announcement of the courses of instruction in the Graduate School of Marine Engineering and Naval Architecture of Sibley College, Cornell University, has just been issued in the form of a 20-page pamphlet. This gives an exhaustive statement of the entrance requirements, expenses, studies, and facilities of the school, and would be of much value to the intending student. A special feature is the opportunity afforded those interested in the development of either the science or art of marine construction to take special courses quite independent of the requirements for a degree or for graduation. For many who have received their training along practical rather than theoretical lines the facilities offered would be invaluable. Copies of the pamphlet can be had upon application to Sibley College.

By an explosion recently on the English mail steamer *France* at Dieppe, six firemen were killed and four dangerously injured.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Kindly give a rule to figure out the pitch of a screw propeller. R. F.

A.—Similar inquiries were answered in detail in our issue of March, 1898. There are a few copies of this issue on sale in this office.

Q.—Is there any point on the path of a crank when it comes to rest? FALL RIVER.

A.—In the ordinary type of steam engine the crank revolves continuously, and does not come to rest or stop at any point in the revolution. On the other hand the cross-head and piston do stop or come to rest for an instant, at each end of the stroke.

Q.—How can I tell the leading crank of a compound or triple expansion engine? P. H.

A.—In a compound engine with the cranks at right angles if you were to stand aft of the engine, and look forward, say, you would see the cranks pass any point, say the top center either in the order *high*, *low* or *low*, *high*, with the right angle or quarter circumference between them. If when passing such a point high comes along first, then high leads; if low comes first, then low leads.

In a triple expansion engine with cranks at 120° the cranks will pass by the fixed point in one of two orders. Beginning with the high it will be either *high*, *intermediate*, *low* or *high*, *low*, *intermediate*. In the former the high is said to lead. In the latter the low is sometimes said to lead, since it takes the place of the high in preceding the intermediate.

Q.—Will you please answer the following questions:

(1) What should be the diameters and pitch for two and three bladed propellers for a 25 ft. boat, engine 5 horse-power, 350 revolutions?

(2) By increasing the pitch of a propeller can the diameter be reduced and the same results in speed be obtained?

(3) What would be the difference in diameters of propellers, two and three bladed single, and two and three bladed ones using two and three mounted tandem on the same shaft?

(4) Would as good results in speed be obtained by using two or three propellers in tandem as by the use of one, two and three bladed propeller? C. H. P.

A.—The information given is not sufficient to properly answer the questions, but estimating the remaining data required the results would be as follows:

(1) For 3-bladed wheel about 21-in. dia. 30-in., pitch.
" 2 " " " 24-in. " 30-in. "

(2) No.

(3) The known results from propellers placed tandem are altogether too limited to make possible the design of such arrangements with any great degree of confidence. It would probably be safe to allow about 20 per cent reduction in diameter for two propellers, and 25 per cent for three, on the same pitch.

(4) The answer to this is connected with that to (3). It is probably possible to obtain practically as good results with two or three propellers tandem as with one, but it would be quite unsafe to count on it without experimental data as a guide in the design.

Q.—Will you please answer the following:

(1) How is the slip of the propeller estimated? For example, knowing the length, beam, draft and model of hull; horse power and revolutions of engines; diameter and pitch of propeller.

(2) How can the diameter and pitch of the propeller be estimated, giving best results for a given horse power and revolutions of engine? V. E. L.

A.—(1) In a case of design the order in which the various items are assumed or computed is usually as follows:

The dimensions, displacement and form of the ship are known. The speed is given.

By appropriate formulae or methods of comparison the I.H.P. is computed.

Next a slip is assumed or selected, together with the pitch ratio of the propeller.

Then the diameter is found by the use of appropriate formulas or methods of comparison.

Then follow the pitch and revolutions.

Then if the various results are correct, the propeller as designed with the given revolutions and slip will develop the thrust necessary to drive the ship at the given speed, and will absorb the I H P. in doing so. All of these various assumptions and computations thus hang together, and an error or variation in any one will affect all the others. The point is, however, that the slip is one of the quantities which is selected out of hand, and then if the expectations are realized the propeller will operate at that slip, and will drive the ship at the desired speed.

In selecting the values of the slip, we are guided by two considerations (*a*) the greater the slip the greater the thrust developed, and hence the less the required diameter. (*b*) The best efficiency is usually found at not far from 20 to 25 per cent true slip, and hence when practicable values in this neighborhood are usually selected.

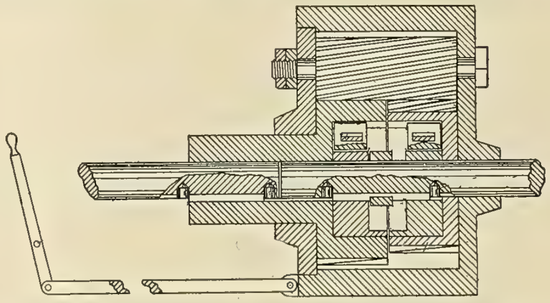
(2) A satisfactory answer to this question would mean a general discussion of propeller design, and this would require more space than can be here devoted to such topics. You are advised to consult some standard work in which the subject is treated.

SELECTED MARINE PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

644,508. Propeller reversing gear. Franklin A. Errington, New York.

The driving-shaft and the propeller-shaft are axially aligned and on the end of the driving shaft is rigidly secured a gear. On the propeller-shalt adjacent this



gear is loosely mounted another gear, a long-faced transmitting-gear meshing with both of these gears. A friction clutch is mounted between the gear on the propeller-shaft and the gear on the driving-shaft.

S. S. PAUILLAC.—Little hope is entertained for the safety of the French Line S. S. *Pauillac*, which recently sailed from New York for Havre, carrying a large number of exhibits for the Paris Exposition. She was last spoken by the S. S. *Germanic* on February 11 last. Among the exhibits on the vessel was a 30 ft. model of the famous Suspension Bridge over the East river at Brooklyn, N. Y., which was complete in construction down to the minutest detail.

MARINE ENGINEERING.

Vol. 5. NEW YORK, MAY, 1900. No. 5

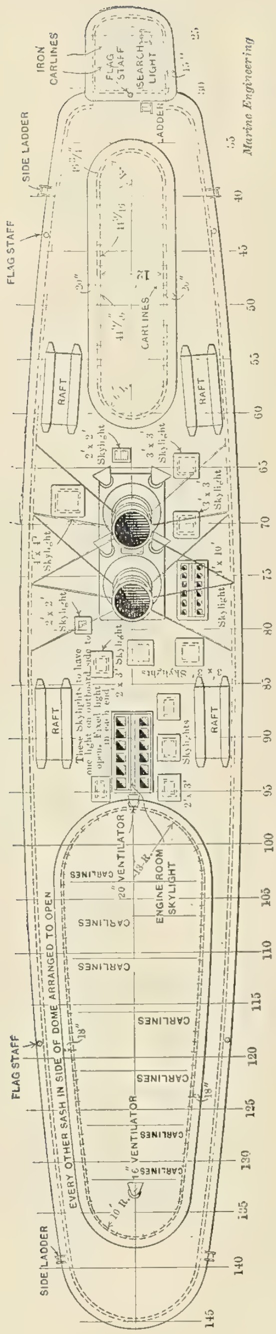
PARTICULARS OF THE LONG ISLAND SOUND STEAMBOAT, CHESTER W. CHAPIN.

Newest among the fast freight and passenger steamers of Long Island Sound is the *Chester W. Chapin*, shown in the illustration on this page, steaming at a lively rate. This fine twin screw steamer is a product of the Maryland Steel Co.'s shipyard at Sparrow's Point, where she was built for the New Haven Steamboat Co. By an arrangement recently entered into the New York, New Haven and Hartford R. R. has secured control of the steamboat company, so that thenceforth the vessels of the company will be operated in harmony with the all-rail interests. This transfer gives practical control of all the Sound passenger lines of steamboats, plying between New York and New England ports, to the Vanderbilt railroad interests.

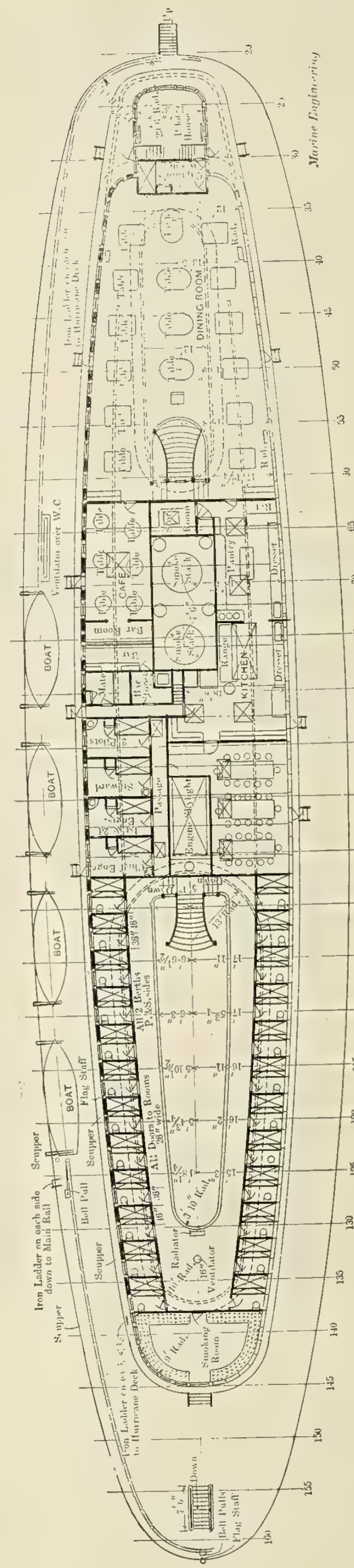
Though the New Haven Steamboat Co. is a very old established corporation, dating, we believe, from 1821, it is only within about 12 months that it extended its service from New York to Providence, R. I., via New Haven, Conn. To enable the company to maintain this additional service the *Chester W. Chapin* was constructed. She is practically a duplicate of the widely known Sound steamer *Richard Peck,* with a slight increase in dimensions, and such modifications in interior design and arrangement as experience with the older boat suggested. The general dimensions are as follows: Length on water line, 310 ft.; length on deck, 324 ft.; beam at water line, 48 ft.; beam over guards, 64 ft.; depth moulded at lowest point of side sheer, 17 ft. 2 1-2 in.; draft loaded, 10 ft. 6 in.; tonnage, 2,868 tons gross; 1,822 tons net.

LONG ISLAND SOUND TWIN SCREW STEAMBOAT CHESTER W. CHAPIN UNDER STEAM.

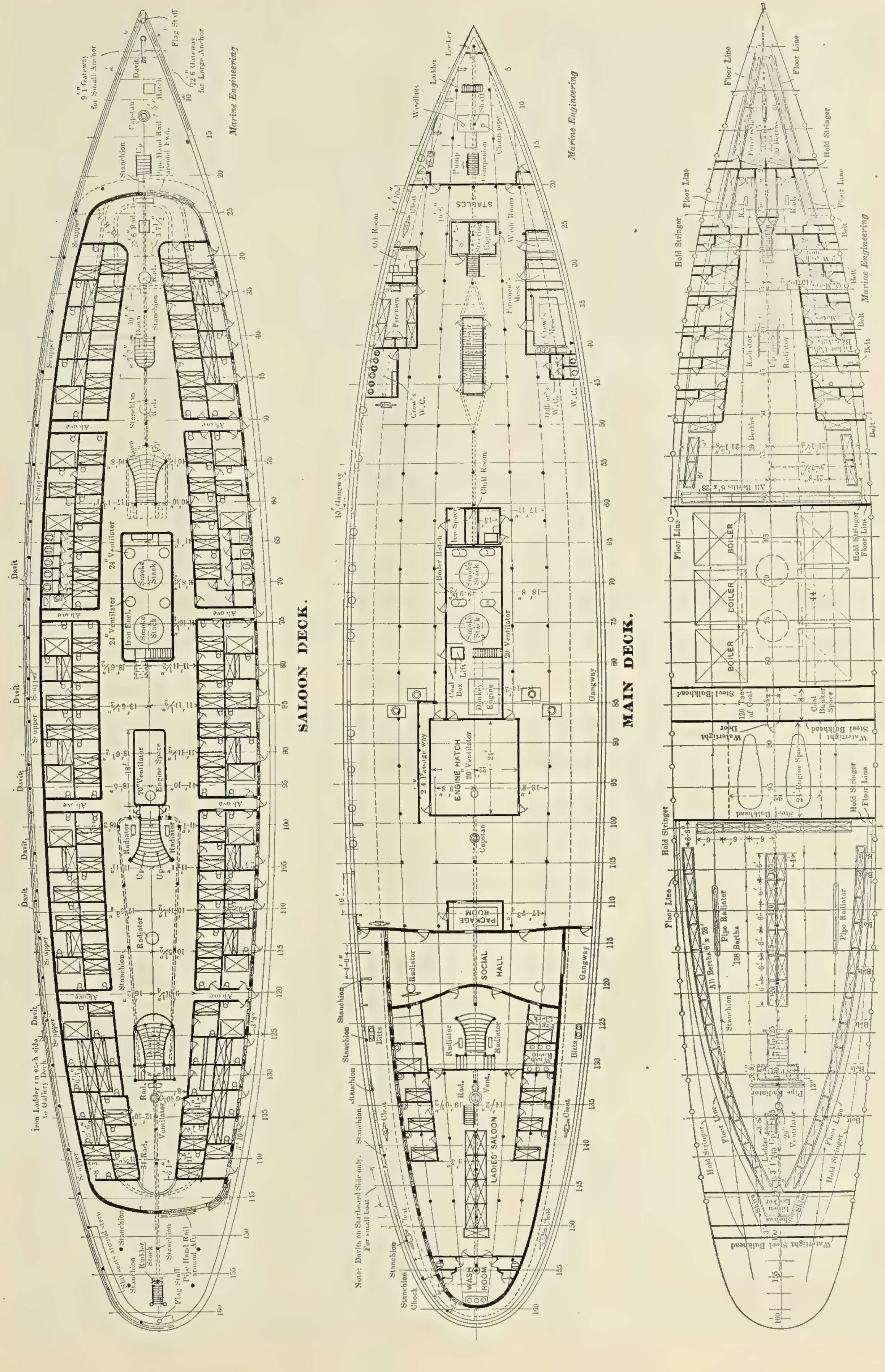
The hull is of mild steel throughout, the scantlings conforming to the highest requirements of the United States standard register, rating A for 20 years. In the accompanying deck plans the accommodations are very clearly shown. The *Chester W. Chapin is* a very comfortable boat and steady in a seaway, being fitted with bilge keels.



HURRICANE DECK.



GALLERY DECK.



DECK PLANS OF THE LONG ISLAND SOUND FREIGHT AND PASSENGER STEAMBOAT CHESTER W. CHAPIN, BUILT AND ENGINED BY THE MARYLAND STEEL CO., SPARROW'S POINT, MD.

In the accompanying reproductions of photographs of the interior the simple elegance of the decorations is apparent, though of course, the color effects are lost, and these add materially to the ensemble. In the main saloon the prevailing tone is old rose relieved with gold leaf. The carpets and hangings are a rich red, and the furniture is of polished mahogany to match. A feature of the arrangements much appreciated by travelers is the location of the dining room on the gallery deck, this being a really fine room, with seating capacity for about 200 passengers.

All modern conveniences, such as steam heating and electric lighting, are installed. The lighting plant has a capacity of 650 15 C. P. incandescent lights, and an 8,000 C. P. searchlight, mounted on top of the pilot house forward.

The propelling machinery consists of two sets of triple expansion surface condensing engines, with cylinders 24 in., 38 in. and 60 in. dia., and 30 in. stroke, of about 4,200 collective horse power. Steam is supplied at 170 lb. working pressure by six boilers, 13 ft. dia., and 12 ft. long, having 390 ft. grate surface and 11,562 sq. ft. heating surface.

The life-saving equipment includes eight 22 ft. life boats, four 16 1-2 ft. life rafts, one 16 ft. cedar dinghy, and 1,100 life preservers.

Designs for the vessel were gotten out by Cary Smith & Barbey, of New York.

Hamburg American Line.—Already in possession of an enormous total of new steam tonnage, the Hamburg American Line is actively engaged in increasing its fleet of ocean vessels. It has now under construction 25 steamships, which in themselves would form a fleet of the first magnitude. The names and tonnage of the vessels are as follows:

	Tons
Abessinia	5,500
Acilia	5,500
Alexandria	5,500
Artemisia	5,500
Belgia	7,500
Deutschland	16,000
Hamburg	10,640
Kiauchau	11,150
Prinzessin Victoria Luise	5,000
Segovia	5,960
Silvia	6,725
Sithonia	6,725
Stiria	5,960
12 new steamers building not yet named	81,825
Total	179,485

The *Deutschland* is, of course, for the New York fast express service of the company; the *Hamburg* and *Kiauchau* are for the East Asiatic service. The *Prinzessin Victoria Luise* is the new cruising yacht which will make her first trip through the Suez Canal to San Francisco, and will return to Germany by the same route. The other steamers are destined for the different services on the north and south Atlantic and on the Pacific oceans.

Institute of Marine Engineers.—At the eleventh annual meeting of the Institute of Marine Engineers, London, England, the election of officers took place, and the following will serve during the session of 1900-1901: President, Col. John M. Denny, M. P.; Honorary Treasurer, F. W. Shorey; Honorary Secretary, James Adamson. The secretary's report showed a membership of all classes of over 1,000, and a healthy financial condition.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—I.

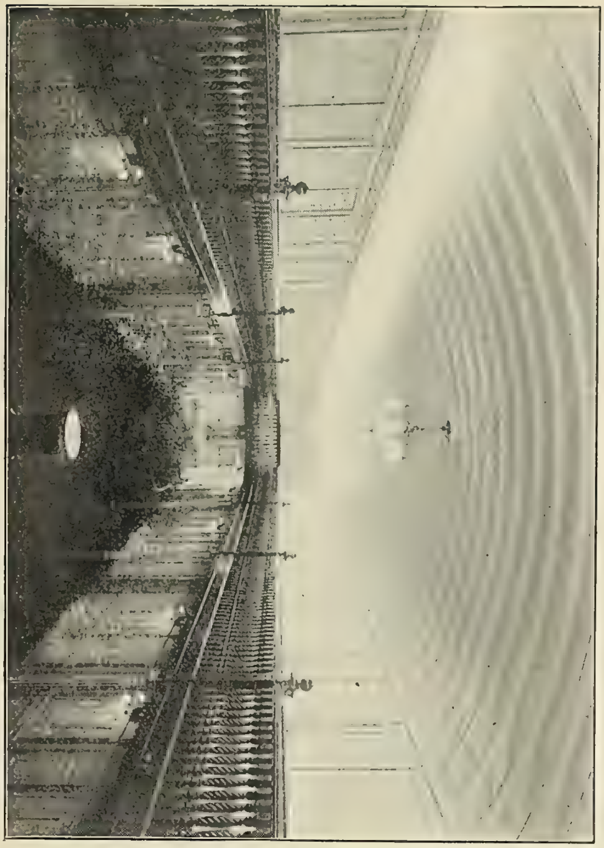
BY ROBERT H. THURSTON.

The analysis of thermal and dynamic energy-distributions in the steam-engine into useful and wasted energies, and the tracing of the stream from its source in the fuel at the boiler-furnace to and through the steam and the engine-piston and on to its work, or, unutilized from the steam and the engine-cylinder into the condenser or out into the atmosphere, has strongly attracted the attention of every intelligent engineer since the time of Watt, whether engaged in the design and construction, in its erection, operation, or in the scientific study of its theory. James Watt was the first to make a scientific investigation of the nature and extent of the wastes of the steam-engine and to reveal their cause, their method and their remedy. Since his time every engineer of reputation has given more or less attention to the subject, endeavoring to ascertain the quantities of energy utilized and wasted, the quantities of wastes remaining to be reduced, the laws of the variation of wastes and utilities, and the processes available for their modification with a view to the amelioration of the defects of the machine and its approximation in structure and performance to the ideal thermodynamic machine.

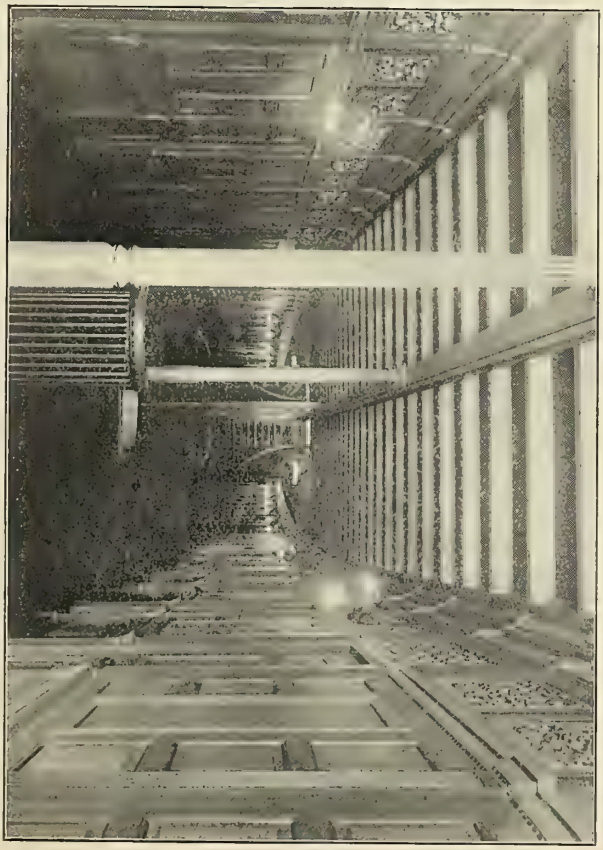
Daniel Kinnear Clark in Great Britain (1852), G. A. Hirn in France (1885), and especially, and by far most completely, Benjamin F. Isherwood in the United States (1859-65), revealed those laws by experimental investigation. Their work has been nobly supplemented by Emery and Dwelshauvers-Dery, and their successors; while Cotterill has shown how to reduce to scientific form and expression the resulting data. It is now practicable to construct a balance-sheet of energies received and expended in such manner as account for wastes and utilities with great precision.

The marine steam-engine has always interested layman and professional alike, more, probably, than any other form of the machine, partly because of its peculiarly striking and romantic duty and the imposing results attained, partly in consequence of the fact that it represents, we may safely affirm, the highest development and illustration of the inventive power of the modern mechanic and engineer, and largely because of the enormous power and striking perfection and economy which it has hitherto exhibited when compared with other forms of the heat-motors. The requirements and the limitations of the case are such, in the application of the marine steam-engine to its work, as to compel the most extraordinary possible combination of power, condensed into minimum space and with minimum weight, yet with maximum economy in the use of fuel and in cost of operation.

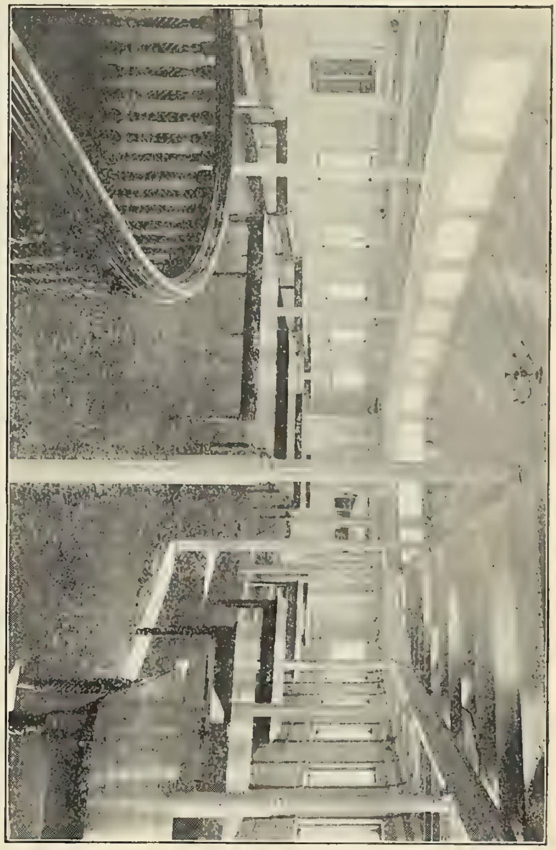
The following study has special interest as relating to the machinery of a noted modern iron-clad of great size, power and speed, as well as general efficiency—the late U. S. S. *Maine*. In comparing the work of such engines, however, with that of engines noted for their extraordinary economy in the use of steam and of fuel, regardless of their size or weight or the magnitude of their boiler-outfit, it is to be remembered that, in the case of the man-of-war, and particularly of



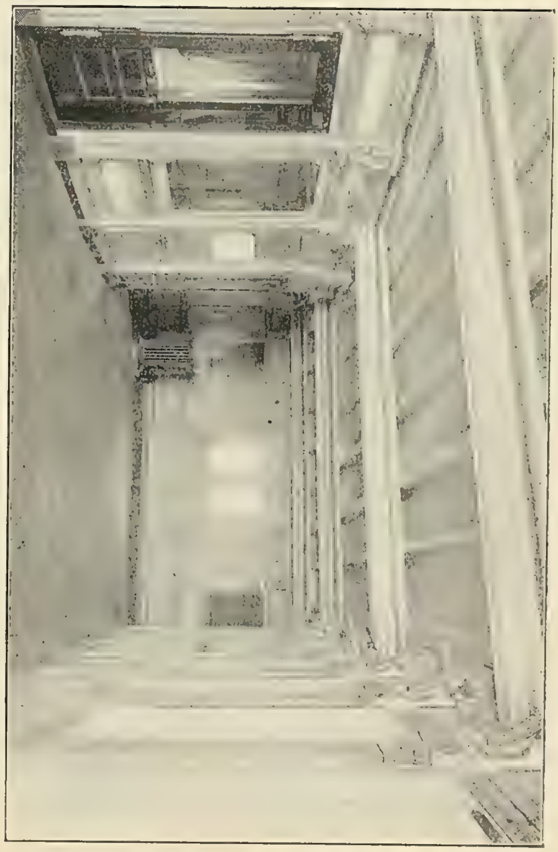
Main Saloon and Gallery.



Main Saloon Forward.



Dining Saloon.



Social Hall.

VIEWS OF INTERIOR OF LONG ISLAND SOUND STEAMBOAT CHESTER W. CHAPIN, BUILT AND FITTED OUT AT THE SHIPYARD OF MARYLAND STEEL CO., SPARROW'S POINT, MD.—SEE PAGE 183.

the iron-clad warship, economy of fuel and of steam at full power is not usually so important as when long voyages are to be undertaken at half-speed. The cruises of war-vessels are made at moderate speed and under restricted powers and maximum economy at high speeds is not important, since it is only in action, and for a few hours at most, at any one time, that the utmost power and speed of the ship are exacted. Economy under such circumstances may therefore be wisely sacrificed, to some extent, to concentration of power into small space and weight. The "record" for maximum efficiency is not held by this class of vessels, or, indeed, by marine engines of any class. While it is true that long-voyage freighters exhibit, properly, great economy of fuel, the highest figures, to date, are given by stationary engines, by steam pumping engines, as always since the days of James Watt. In the merchant service, nevertheless, the inducements to secure high economy are exceptionally great. The first cost of fuel is great, comparatively, since it must always be of good quality. It must be economized, not only because expensive, but also because every pound weight and every cubic foot of space occupied displaces a pound or a cubic foot of paying freight. On the other hand, the engines and boilers also displace paying cargo, and must be made as small and as light as may be found consistent with economy in the use of fuel. The whole design of a steamship, in fact, is a series of compromises between these various claims, and final results are more or less satisfactory accordingly as the net total outcome, measured on the books of the treasurer of the company, shows more or less earning power and a higher or lower ratio of returns to expenses of operation. Every principal proportion must be studied with reference to ability to improve permanently the dividend-earning power of the line. In the case of the war-steamer, the designer seeks the greatest possible concentration of power, a minimum weight and space with maximum power, or with a stated demanded power. Not only does such concentration lighten the ship; but in this case each pound saved or each cubic foot thus economized, gives opportunity to add to the battery or stores, or to increase the thickness of armor. Reduction of weight and volume to the lowest possible figures, and as high economy as is consistent with these primary aims, are the ends sought by the designer of the naval steamer. The following study of such a case will give some idea of the extent to which high thermodynamic efficiency is actually attained in such vessels.

Before taking up the data derived from the trial of the vessel, we will first see what would be the efficiency of a perfect thermodynamic engine, with steam pressure ranging, as during the progress of the marine engine since about the middle of the century, from, we will assume, 30 to 160 lb. per sq. in. absolute. The actual variation in customary steam pressures during this century is shown, as reported by a number of observers for this period, on the accompanying plate, Fig. 1.

It is found that steam pressures and efficiences are still rising, and the indications are, at present, that they will continue to rise for a considerable time to come. It is now possible to obtain safe steam-boilers for any pressure that may become usual and generally desired, and this has been, from the first, the real limit of advance in this respect. The introduction of the water-tube boiler of Stevens and Perkins has made pressures available that could not have been otherwise dreamed of.

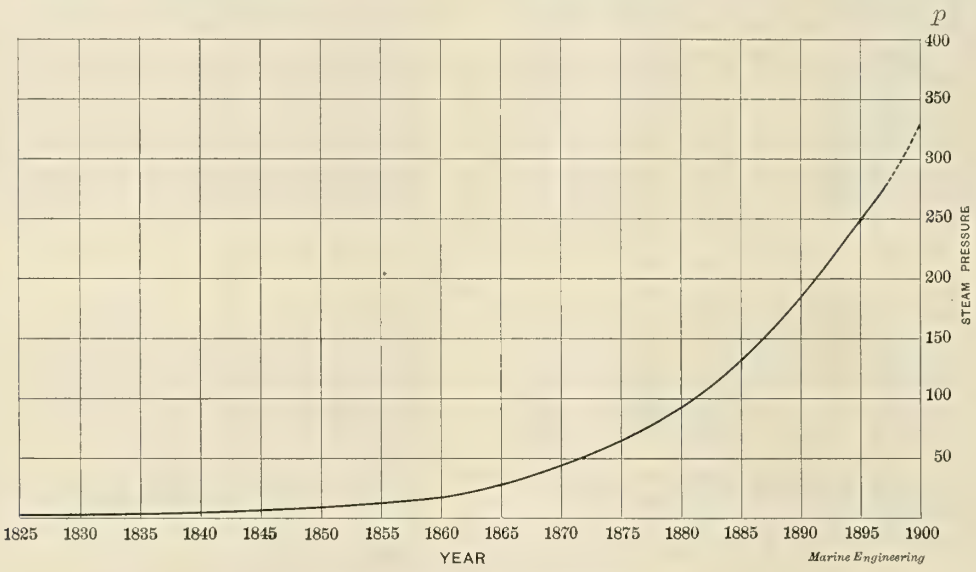


FIG. 1.—RISE IN STEAM PRESSURES.

The rise of pressure has been, on the whole, a fairly uniform one in rate and regularity during the generation just past, and, if this should continue another generation, the indications are that the year A. D. 1900 may see 300 lb., and possibly more in common use; and it would seem possible that only the approach to temperatures rendering our materials of construction no longer reliable may limit this advance. At the current rate of progress it will still be a century before we make standard those pressures which were experimentally employed, and with safety and comparative

economy, by Jacob Perkins a half-century ago. Forty years hence, the promise of our diagram is that customary pressures may be as high as 400 lb. per sq. in.—27 atmospheres. The sharp bend in the curve limits the period of the simple engine of James Watt, and marks the inauguration of the period of multiple-expansion engines. The steadiness with which the curve adheres to its uniformity of radius subsequent to that period would ordinarily be taken as evidence that we may fairly expect steady and uniform progress at a similar rate in the immediate future; but no one can say at what moment obstacles of insurmountable, or of slowly surmountable, character may arise to change the law of the curve. Perkins, however, in 1824-36, employed pressures of, first, 500 lb., then 1,000 lb., and finally of about 1,500 lb. per sq. in., with a ratio of expansion of 8, and obtained, as he says, one horse-power with but two bushels of coal per day, or less than two pounds per horse-power per hour, with but a fraction of the expansive action practicable to-day. With modern sectional boilers, and skill in design and construction, and guided by the light of modern science, now illuminating a then dark field so completely, it would be strange if our engine builders could not do better than Perkins, and enormously better than they are usually to-day doing.*

While increasing steam-pressures have been an important, an essential, element of progress, as securing better thermodynamic conditions, and have thus permitted a wider range of thermodynamic transformation, rising piston-speeds have as continuously aided in reducing the extra thermodynamic losses of the engine, and, contributing thus to the net result, have been, and still remain, one of the most important of the elements of high efficiency. The next illustration, Fig. 2, exhibits a diagram of the relation of piston-speeds to time which will forcibly present to the mind the relation of this economic condition to the progress already illustrated in improving duty. Not infrequently speeds have been adopted in marine work, especially, considerably higher than here shown, and 1,000 ft. a minute is not an uncommon figure in practice. This high speed of piston has the double advantage of reducing "cylinder condensation," and thus of making the constructor more or less independent of super-heating, of compounding and of jacketing as methods of its amelioration; while, at the same time, increasing speeds give increasing power in full proportion. Power is a product of the two factors, resistance overcome and speed of velocity of action. Of these two factors, speed is that which costs nothing in size, weight or expense of construction. A steam engine working at a speed of 500 ft. a minute has just one-half the power, and is considerably less economical, usually, than the same engine at 1,000 ft.

A standard of efficiency is required, in comparing the economical performance of steam-engines, precisely as a standard is needed for weights and measures, or for coinage. This standard has for its ultimate measure the "mechanical equivalent of heat," as Joule called it, the thermal equivalent of work, as it may just as well be called. Energy measured in the dynamic form, and the equivalent amount of energy in the thermal state, have the relation of equality between 778 foot-pounds of dynamic energy and one thermal unit in British measures (*B. T. U.*). With perfect transformation of heat into work, each unit will be found to produce, by its conversion into the other form of energy, 778 foot-pounds of work. Any heat-engine of perfect form and of perfect efficiency, of efficiency unity, would do work in this proportion to heat supplied it.

The above statement is equivalent to saying that 2,545 *B. T. U.* per hour are the equivalent of the horse power, 1,980,000 foot-pounds per hour. Similarly 42.42 *B. T. U.* per minute are the equivalent of the 33,000 foot-pounds per minute, which are conventionally taken by the engineer as equal to horse-power. The quan-

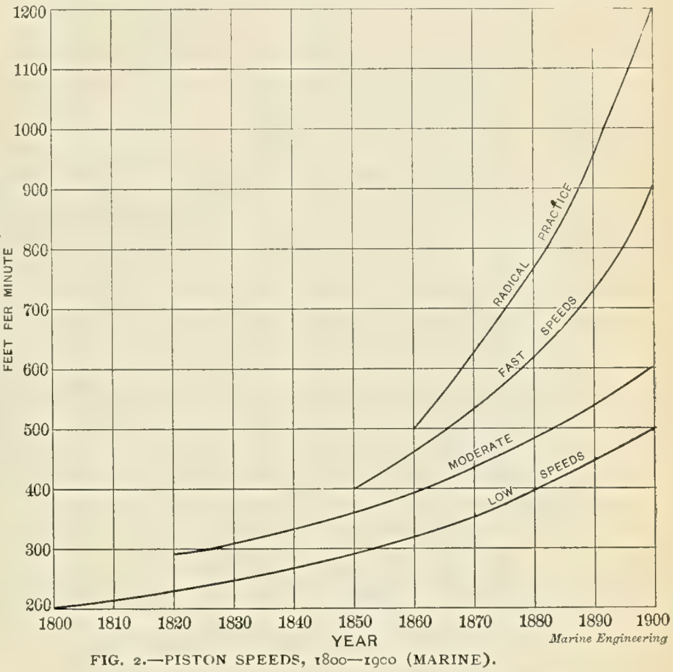


FIG. 2.—PISTON SPEEDS, 1800—1900 (MARINE).

tity of steam demanded per horse-power, at efficiency unity would depend upon the amount of heat supplied the feed-water, per pound, at the boiler. With a condensing engine, raising the temperature of the feed from that of the hot well and condenser to that of the boiler-steam, and evaporating it into steam at that pressure, the quantity of heat communicated per pound is commonly about one thousand thermal units, and the horse power demands from 2.3 to 2.5 pounds of steam per hour. This, again, is the equivalent of about one-quarter of a pound of good coal. These several measures of equivalence may be termed the several forms of expression of the *absolute* standard. But we need also standards of *relative* performance, by means of which to compare the efficiencies of the real engine with the computed efficiencies of the ideal machine of similar cycle. Of these standards, a number are found useful, each in its own way and for its special purpose.

*Perkins employed a Woolf compound engine as early as 1827, and for his latest work with his highest pressures. Had Perkins and Alban, the distinguished German engineer who followed in his track, employed larger expansion ratios, and triple and quadruple expansion engines, it is more than possible that we should be to-day using, regularly and customarily, pressures exceeding these. Progress must apparently always be in that direction; we can see no way of increasing our engine efficiencies by reducing the lower limit of temperature and pressure.—R. H. T., Trans. A. S. M. E. Contemporary Economy of the Steam Engine.

The Carnot Cycle affords a relative standard by means of which the wastes of the real engine may be determined, so far as they are due to departures from the most perfect economic conditions and the most perfect possible thermodynamic cycle. Worked in this cycle, whatever the character of the working fluid, the efficiency is a maximum, and always measured by the ratio of the range of temperature worked through to the maximum, absolute, temperature of the cycle. In all cases we have a diagram composed of a pair of adiabatic lines, crossed by a pair of isothermals; all the heat received is taken into the system at the maximum, and all that is rejected is discharged at the minimum temperature, and transfer from isothermal to isothermal always occurs adiabatically. The difference between the heat received and that rejected is converted into work, and the ratio of work performed to heat supplied, the measure of efficiency, is given in turn by the difference of temperatures of reception and rejection, divided by the maximum temperature, on the absolute scale:

$$\text{Effic.} = (T_1 - T_2) / T_1.$$

Computing the quantity of heat or steam or fuel required in the given case for efficiency unity, the division of these quantities by the Carnot efficiency of the given cycle gives the measure of the maximum thermodynamic efficiency attainable by even a perfect engine, and the difference between the value of this efficiency and that of the real engine, with which comparison is made, affords a measure of the sum of all wastes, thermodynamic and extra-thermodynamic, so far as they constitute the economic difference between the ideal and the real engine.

In making such computations of efficiency, we require the following data only: the initial and final pressures and temperatures of the working fluid, and, for special purposes, the volumes of the fluid in the several states, and under the various conditions, marking critical points in the cycle. To determine the weights of steam and of fuel, the sensible and latent heats must be ascertained by consultation of the "steam-tables" and the quality of the fuel, as determined by chemical analysis, or by combustion, for the ideal case, and by a steam-boiler trial for the real engine, must be accurately determined.

The Carnot efficiencies being thus computed, the comparison of these figures with those resulting from a trial of the engine will furnish a measure of the relative value of the latter, of the nature and magnitude of its wastes, and of the range remaining for further improvement.

A relative standard of efficiency of still more actual value, perhaps, is the ideal case as computed on the assumption that an engine can be made of similar cycle with that adopted in the actual case, but free from extra-thermodynamic wastes.

U. S. S. Kearsarge.—On a two hours full power trial, natural draft, the U. S. S. *Kearsarge* gave the following results: Average revolutions, starboard, 98.7; port, 96.9; vacuum, starboard, 26 in.; port, 25.5 in.; steam pressure, 154 lb.; coal per hour, 18,480 lb.; I. H. P., 8,483.35; main and auxiliary engines, coal per I. H. P., 2.18 lb.; average speed, 14.99 knots. The mean draft when leaving port for trial was 23 ft. 7 in. Pocahontas coal was used.

MAIN OFFICE BUILDING OF THE NEW YORK SHIPBUILDING CO., CAMDEN, N. J.

Since the purchase of a site for the new shipyard at Camden, N. J., the New York Shipbuilding Co. has been unceasingly at work getting the plant ready for operation. The site selected covers, as our readers will recall, about 120 acres, and field work was begun July 3 last. Pending the completion of the office building at the yard, headquarters were established in one of the large office buildings in Philadelphia, but these have now been transferred to the office at Camden, which has been completed and fully made ready for occupancy.

This building is of much interest to the engineer, as it has been laid out with a proper appreciation of the needs of a modern, up-to-date office, and the thoroughness which has marked all the operations of this company is displayed in both the design and equipment. The accompanying photograph gives a very good idea of the main office. The building is in the old colonial style, very appropriate in the section in which it is situated. It is located on a lot, 460 ft. by 210 ft., on the opposite side of the street from the main entrance to the yard. About 400 ft. distant the main shops are situated, with the street, the yard office, power house, and general store room intervening. Street car lines pass the door and connect with the Camden ferries to the city of Philadelphia, and stations of the Pennsylvania and Reading railway systems are located at the rear within three minutes walk.

The building is located 50 ft. back of the curb line, and is 130 ft. by 116 ft., and contains two stories and basement. The foundations are concrete with granite water table; the walls are dark red colonial brick, with thick cement joints, raked out and trimmed with Indiana limestone. The main entrance is also of Indiana limestone of colonial design, with heavy pediment.

In the accompanying floor plans the accommodations can be read at a glance. The interior finish of the building is of white oak quartered and finished dark. Great attention has been given throughout to the important feature of lighting. Walls and ceilings are painted in oil, with various shades of green, depending on the amount of light admitted to the rooms. The upper portion of every door and partition is of chipped glass. Chocolate colored plain linoleum is laid on the floors, and quartered oak, richly polished, is used for all the furniture.

A feature of the structure is a great fire proof vault, 40 ft. by 20 ft., and extending through three stories. In the lower floor such archives as will be seldom referred to will be stored. The middle story of the vault is divided into three compartments, for holding hull department drawings, engine department drawings, and for letters, estimates and other valuable papers. The upper story is divided into two compartments, and will be used for the storage of data and papers belonging to the cost and accounting department, and for the use of drawings pertaining to the construction and maintenance of the plant.

In the basement the entire south side is laid out in three dining rooms, occupying a space 120 ft. by 24 ft., with capacity for 200 persons at one sitting. One of these rooms is a private dining room, another the

dining room for the general officers, and the third is the general dining room. Kitchens and serving room, equipped with every modern convenience, a large refrigerator, and pantries, are conveniently placed.

On the north side of the basement the office engineer's room is located, also a bicycle room, approached by a slope, and a room 50 ft. square to be used for exhibiting ship appliances and fittings. One hundred separate lockers are situated along the main corridor for the use of the draughtsmen.

In the toilet rooms the newest sanitary appliances are fitted. One toilet room is located in the rear of the basement, and is reached by stairways from each of the drawing rooms; the other room is in the basement proper, and is approached by a stairway from each front corner of the building.

The first floor is exclusively for the use of the executive departments, and has separate accommodations for the engineers, draughtsmen, estimators and librarian; thus bringing together on one floor all employees engaged in securing work and in preparing data having reference to the output of the yard.

Special care has been taken in the arrangement of rooms so that each of the officers will be located conveniently to the various departments with which he will have frequent communication. By an inspection of the first floor plan, on page 191, for example, it will be noted that the president's office adjoins that of the private secretary and board room on one side, and the private library, superintending captain and general superintendent on the other side.

The functions of the superintending captain will be to advise with the president, general superintendent, naval architect, chief engineer and marine engineer with reference to the proper construction of ships and conveniences in arrangements and handling.

The office of the general superintendent is situated between that of the president and superintending captain on one side, and the estimator, naval architect, chief engineer, marine engineer, draughting rooms and librarian on the other.

Between the rooms of the executive officers and the draughting rooms come the quarters for the chief engineer, naval architect and marine engineer. This space extends over the entire length of the building—that is 130 ft.

On the other side of the first story are the offices for the cashier, treasurer, vice-president, purchasing agent and his clerks, and the librarian. These are arranged so that the purchasing agent is situated between the vice-president and treasurer on one side, and the clerks and librarian on the other.

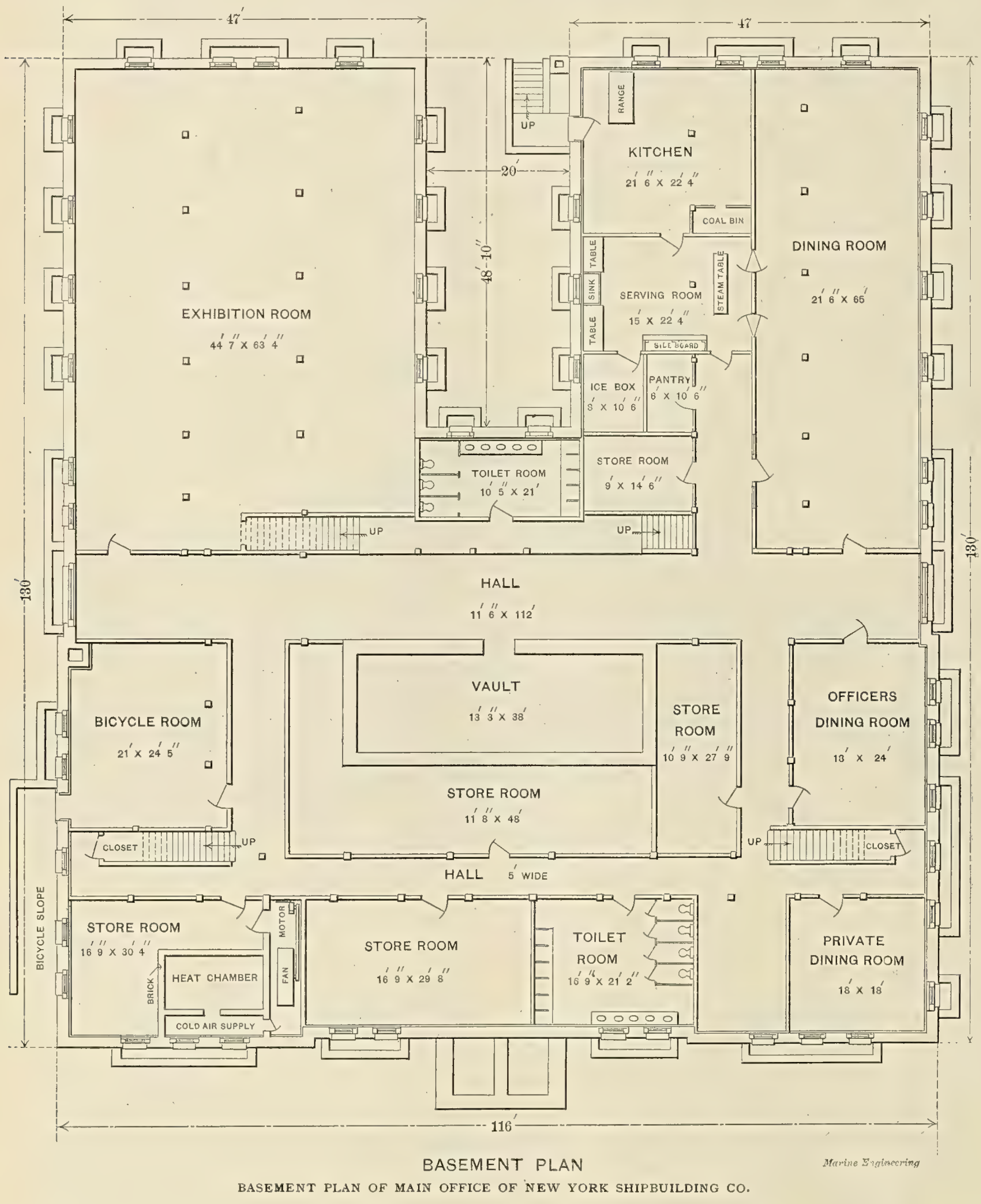
The duties of the librarian will be to take charge of all tracings, catalogues, books, estimates, letters, and in fact, all data for use by all the officers and employees. A memorandum of all letters received will be made by him before distribution, all answers to letters will be copied by him, and the copies retained and filed. As soon as tracings are finished and approved they will be delivered to the librarian and blue print copies will be distributed on requisition, the blue printing department being entirely in his charge. All data pertaining to the purchasing department will be received, catalogued and classified by him and temporarily delivered to the purchasing agent for use. The librarian will also have charge of the general library and all periodicals. The latter will be purchased in triplicates, one copy being bound and filed in the library, the other two cut up and properly classified. The object of establishing this department is to relieve all the officers and stenographers of the burden of arranging, classifying and filing, and especially the remembering of such data as they are called upon to use frequently.

MAIN OFFICE BUILDING OF NEW YORK SHIPBUILDING CO. AT CAMDEN, N. J.

On the second floor the accounting department has large office space, and here also are the quarters for the staff occupied with the maintenance of the plant.

The secretary, whose office adjoins that of the accounting department, will have charge of all the bookkeeping and cost accounting. Accommodations for the maintenance staff will include offices for the mechanical engineer, electrical engineer and civil engineer in charge of the yards and docks. Adjoining each of these officers' rooms is a separate draughting room for his special use. In the main body of the office on this floor there is a fine model room. In the north corner of the office there is extensive accommodations for blue printing and photographing department, which will be under the control of the librarian, who will, also, have charge on this floor of the vault containing drawings and data for the maintenance of the plant.

In the southeast corner a tracing room is fitted, where



BASEMENT PLAN

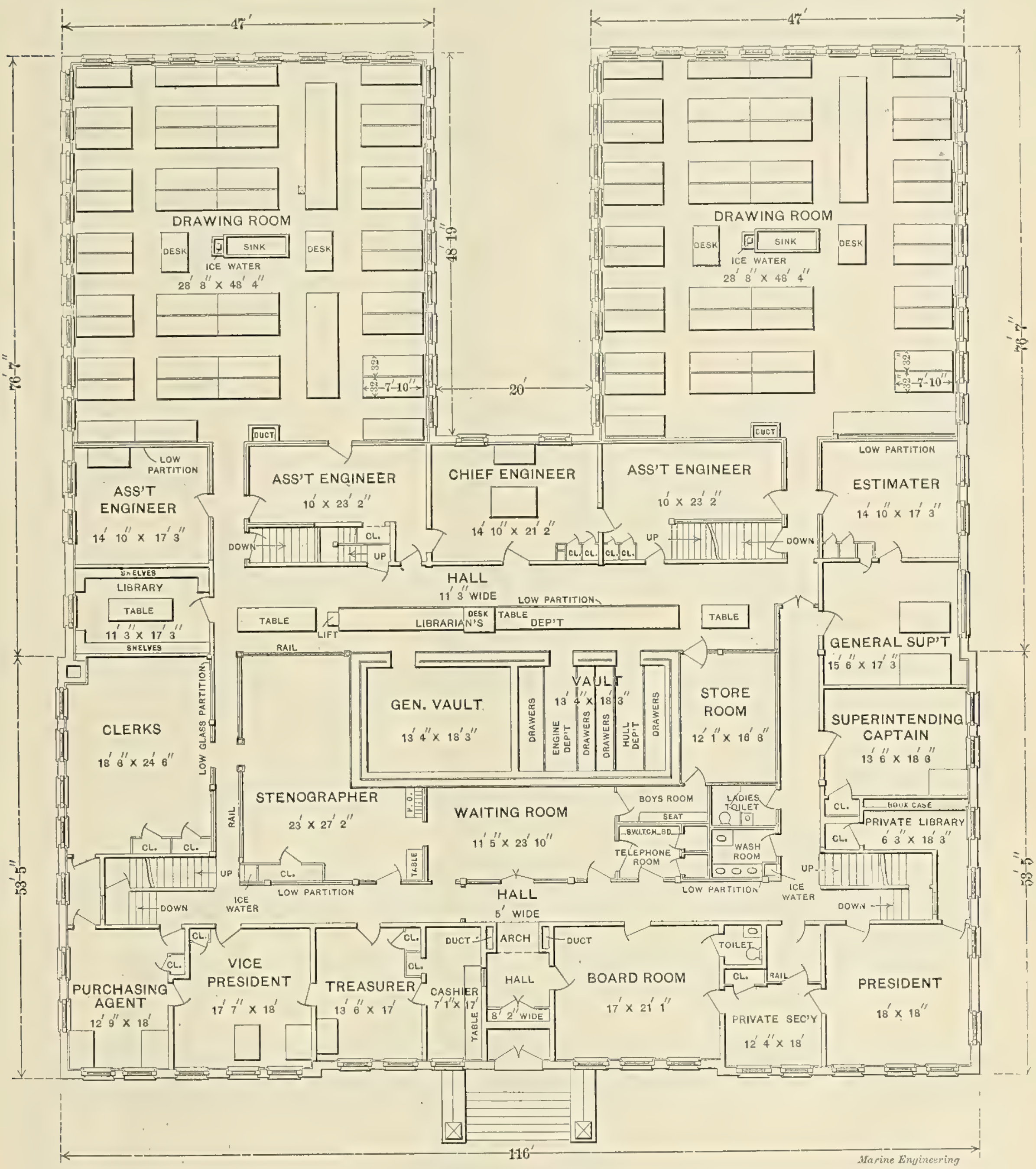
Marine Engineering

BASEMENT PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

work of this character will be carried on, so as to relieve the draughtsmen of both the hull and engine departments.

An adequate water supply has been provided throughout the building. Each floor will be supplied with a constant flowing stream of water at a temperature of 55 deg., pumped from an artesian well. Wash rooms and drinking fountains of the two draughting rooms are situated in the center of each room, and other similar fittings are located conveniently for the use of the executive officers.

Heating and ventilation have been carefully considered in the design of the office. It will be heated in cold weather by exhaust steam from the power house, situated 300 ft. distant, by both the direct and indirect systems. The indirect system consists of a heating chamber through which air from the outside of the building is drawn by a large fan and distributed to each room

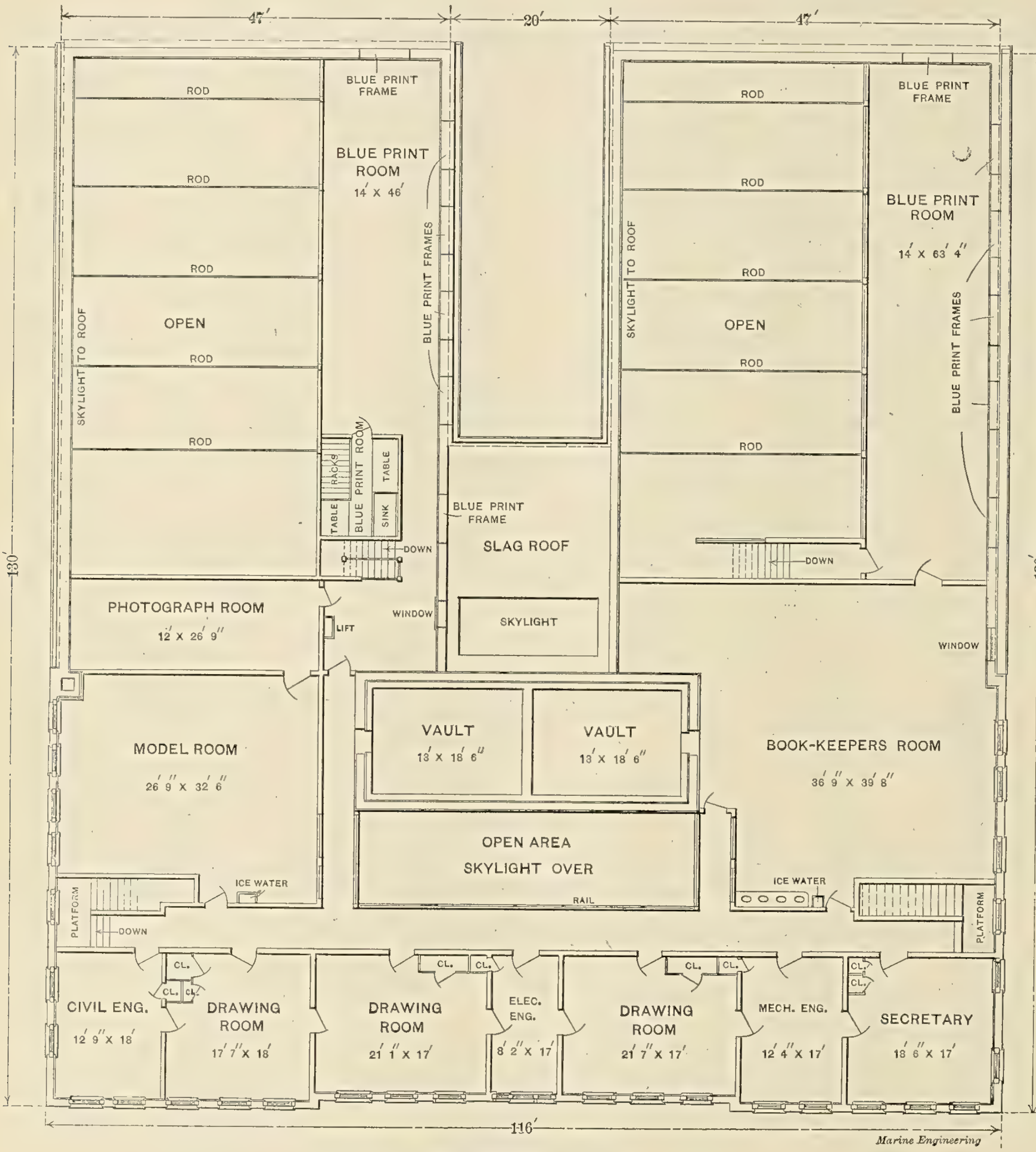


FIRST FLOOR PLAN

FIRST FLOOR PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

in proportion to the number of occupants of the room. A sufficient quantity of air is forced in to effect a complete change of air in the room once in every five minutes. During the summer season this system will be used to keep the air fresh in the rooms. A direct system of heating by steam radiation is also provided in all rooms, but this will only be needed in excessively cold weather.

For purposes of quick communication throughout the entire plant a very complete telephone system has been installed, with the central station located in the main office on the first floor. This, when completed, will have a capacity for 130 telephones, of which 100 will be used in connecting the various offices of the main works and thirty in the office building proper. Each department in the office will have a connection through the central station with every other department by desk-phone, and with every part of the works where wall instruments will be fitted. For lighting the office the building is wired for direct current, and incandescent lamp fixtures are fitted wherever needed, the current being supplied from the power house in the yard.



SECOND FLOOR PLAN

SECOND FLOOR PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

In a description on paper it is not possible to cause a full appreciation of the facilities in the building for

effective and convenient operation, such as would be experienced by a personal inspection. To those who have had experiences with old time shipyard facilities the new building would seem a creation of fancy rather than fact, so completely does it meet the needs of modern work. The size of the building can be better appreciated by a comparison which shows that the two upper floors are in dimensions equal to 100 rooms, 15 ft. by 15 ft., or floor space equivalent to a 40 ft. by 60 ft. building ten stories high.

The architects of the building, as well as of the main shops, are Hale & Amory, 15 Exchange St., Boston, Mass., and Henry G. Morse, Jr., associate architect, has direct charge of the construction and arrangements on the ground. The general constructor for the building is the J. S. Rogers Co., Camden, N. J.

ONE AND TWO-WIRE SYSTEMS OF ELECTRIC DISTRIBUTION, COMPARATIVELY DISCUSSED.

BY ALTON D. ADAMS.

The fact that the largest steamship in the world, the *Oceanic*, has recently been fitted with an electric plant for which the hull serves as one set of main and branch conductors between the dynamos, lamps and motors, emphasizes the claims of advantage made for the one-wire system of ship lighting.

The usual American practice in ship plants is to run a complete, copper circuit of two insulated wires, to which the dynamos, lamps, and all current-consuming devices are connected. This system has no electrical connection with the hull of the ship; both terminals of the dynamos are carried to the switchboard and double pole switches and fuses are provided for all circuits.

In the one-wire system of ship lighting, one terminal of each dynamo, usually the negative, is connected directly with the steel hull of the ship, commonly by a contact plate in which a cable from the dynamo terminates. The other, or positive dynamo terminal, is carried to the switchboard and connected through single pole fuses and switches with each of the wires leaving it. The single wires going from the switchboard each represent one side of a circuit for which the hull of the ship is the other. Each wire connects with its group of lamps, motors or other devices, and the other terminal of each lamp or motor is secured to the ship's hull.

The advantages of the one-wire system include a saving in both materials and labor. As all of the switches are single pole, the weight of their metal parts is only about one-half of that for double-pole switches. Fuses also being single pole, their parts require only about one-half the weight and space of the two-pole type. The smaller number of switch and fuse parts require a smaller and more simple switchboard for mounting them, also smaller distribution panels at other points. The greatest saving of materials effected by one-wire plants is in the weight of copper required for distribution.

The weight of wire required for the circuits of electric plants varies inversely as the electric pressure or volts consumed between their terminals, when the full rated current is flowing, other factors remaining constant. As two wires of equal size and weight connect each lamp or motor with the dynamos, the use of the ship's hull for one side of the circuit reduces the total weight of wire one-half, provided the sizes of wires used for the other side of the circuit remain the same as in the two-wire system. The loss in a wiring system, however, is properly decided on questions of lamp regulation, heating of conductors and power loss, so that the same loss of pressure in the entire circuit is desirable whether the two-wire system or the one-wire with hull return be used. Hence it is said that, since the electrical resistance of the hull is very small, the resistance of the wires in the one-wire system may be twice as great as that of one-half of the circuit in the two-wire system; that is, may equal the entire resistance of the two-wire system. If this claim is correct the wires of the one-wire system with hull return may be of only one-half the size of those in an equivalent two-wire system, for the same loss of power and pressure, and the weight of copper necessary for the one-wire plan is, therefore, only one quarter of that with two wires or a complete copper circuit.

Simple as it thus appears to save seventy-five per cent of the weight of copper necessary for two-wire ship circuits, there are very good reasons why no such saving can be made in practice, for the great majority of cases. A suitable loss of pressure in the wiring of ship plants usually ranges from two to five volts at full load, being largely decided by considerations of pressure regulation at lamps as well as some regard for loss of power. There is, however, another important factor that cannot be ignored, namely, the safe carrying capacity of the wires; that is the rate at which current, as measured in amperes, may flow through them without causing so great a rise of temperature that they become a source of danger as to fire. Now the safe carrying capacity of a given wire is a constant quantity under the same conditions, depending upon its sectional area and the kind and quantity of its insulation, while the maximum loss of pressure that may occur in a conductor varies directly with its length, and may be very small if the conductor is quite short. In the design of the two-wire system for ship plants with losses of from two to five volts pressure in the wiring, the permitted pressure loss determines in most cases the size of conductors, rather than considerations of safe carrying capacity. The practical effect of the hull return is to cut the length of wires in two, so that if the same loss is to be had in the wires of the one-wire system that would be allowed in the two-wire system for the same service, it will often be found that the permitted loss involves too great a rise of temperature in the wires, and is, therefore, larger than is permissible. In this case the only course is to select some larger wire whose safe carrying capacity will not be exceeded by the desired flow of amperes. In many cases, for the distances common in ship plants, this limit as to safe ampere capacity of wires will be found to require about the same sizes of conductors in many parts of the one-wire system as would be used for the two-wire.

Another practical limit to the reduction of the areas of wires in the one-wire plan is found in the fact that, for mechanical considerations as to strength, the smallest wire that should be used for general purposes in either the one or two-wire system is about .064 in. dia.,

and much more of this particular size, as to length, will be used than of any other. The result of the considerations just named, together with the fact that the weight of insulation does not vary so fast as that of its contained copper wire, tends to keep the sizes of wires for the one-wire system and also their weight at about that in one-half of an equivalent two-wire circuit.

Even on the supposition that the hull of a ship offers no electrical resistance when used as the return for a wiring system, it is by no means possible, therefore, to reduce the section and weight of wire in the one-wire system to one-fourth of the amount required for the two-wire plan. A little consideration will show, however, that to regard the return circuit through the ship's hull as of no resistance is a mistake. One of the fixed rules for the erection of electric wires is that all joints between wires be soldered to insure a low resistance at these points. At switch, fuse and socket terminals clamp joints are permitted, but special contact parts of relatively large surface are provided at these places, and these clamping parts are always of brass or copper, the surface of which is much less subject to the formation of oxides than is that of iron or steel. Now the oxides that gradually form on the surfaces of metals are the main cause of the increasing resistance of unsoldered joints. When metal surfaces are perfectly clean the resistance of a tight joint between them can be lowered but little by the use of solder, but the solder prevents the formation of oxides in the jointed surfaces. It is well known that any iron or steel surface to which damp air has access soon becomes coated with oxide, and this result can hardly be avoided in the hundreds and thousands of contacts between electrical fittings and the hull of a ship, when the latter is used for the return circuit. The result is that a resistance at these joints, which may be trifling when the fittings are first erected, is apt to become quite a serious matter at the end of five or ten years. The hull of a ship, made up with a great number of steel plates, obviously has many joints which an electric current flowing between distant points on the ship must cross. These joints between ship plates are, perhaps, less subject to corrosion than are those between electrical fittings and the hull, but there must be some action of this kind, and the scale on the plate when they are at first joined is rather a poor electrical conductor. Considering both the joints between electrical fixtures and the hull, and also those between the hull plates, it seems practically certain that whatever the resistance of a return circuit through the hull when the ship is new this resistance will gradually increase and ultimately reach a very material amount. The resistance of a well designed two-wire system for a ship plant is in any case small, and it is at least doubtful whether the ship's hull and the connections thereto would, after a term of years, have a less resistance than one side or half of a proper two-wire system. At a time when electric plants on board ship were quite small and performed no service apart from lighting, the hull was more apt to give satisfactory results as a return circuit than now, when many hundreds of amperes flow from one part of the ship to others for the operation of lamps, motors and heaters.

Considering the factors of mechanical strength, ampere carrying capacity, and the uncertain and increasing resistance of joints, it seems impracticable to reduce the wires of a one-wire system below the sizes that would be used in the corresponding half of a two-wire plant. If the same sizes of wire are used in the two systems for a given case, the one-wire plant will require just one-half the weight of conductors necessary for the two-wire. Some labor will no doubt be saved in the one-wire plant, but its amount will not be so great as might be supposed, since twin-wire cable is not much harder to erect than a single wire, and the labor involved to secure proper attachments to the steel plates of the ship's hull cannot be neglected.

The cost of a wiring equipment on board ship must depend on a number of factors peculiar to each case, important among which are the loss of pressure permitted in conductors and the size of the ship. Allowing for the use of the same sizes of conductors in both systems, however, the total saving of labor and material by the one-wire plan will probably not exceed one dollar per lamp (16-candle power) capacity of the plant for an average case. To offset this rather small saving of first cost for the one-wire plan, it has a few decided disadvantages. Whether electrolysis at the joints between the steel plates of a ship's hull will ever become of importance is as yet an open question, but a practical demonstration of such effects on the hull of a ship may prove an expensive lesson. That heavy electric currents can work great damage when passing out of iron surfaces where moisture is present, and that with little warning until destruction is nearly completed, now has been fully demonstrated to the dissatisfaction of water and gas companies in many parts of the country.

It sometimes happens that the terminals of a fuse become short circuited or joined through a burnout, or that an arc continues between fuse terminals after the fuse has been melted by a heavy short circuit at some point on the line which it protects. In a two-wire system either of these mishaps is usually cared for by the fuse on the other wire, since double pole fuses are regularly used on two-wire work. In the one-wire plant there is no duplicate fuse to blow and open the connection, so a fuse designed to protect some larger wire must either blow out or else the wire which the faulty fuse connection was designed to protect must melt and thus produce a very real danger of fire. The known nature of an electric current is to expend the most of its energy in the generation of heat at those points in its circuit where the resistance to its flow is the greatest. This is illustrated by the incandescent lamp, which consumes most of the energy of the current flowing through it simply because its resistance is usually many times that of the wiring to which it is attached. As the joints between the electrical fittings and the steel hull of the ship grow old some of them are apt to develop a high electrical resistance through being loose or rusted, and such loose joints may become a serious danger as fire risks, because of their development of heat, against which no fuse on the circuit can guard.

In a two-wire plant one-half of the total electric pressure acts, under normal conditions, to break down the insulation of either wire or pole, while in a one-wire system, with a hull return, the entire effort of the pressure is to pierce the insulation at the single wire pole. For equal security against this effect alone, therefore,

the insulation of a single wire system should be of double thickness. It is regular practice in the erection of two-wire plants to install at the switchboard a device that will indicate at once when an accidental ground, or, in the case of ships, iron connection, occurs in any part of the electric circuit, so that it may be removed. As a one-wire circuit with hull return is in direct contact with the iron of the ship at a great number of points, an accidental contact in any place cannot be indicated at the switchboard, but is revealed only by the injurious effects it produces locally in the way of heat or fire at the place where it occurs. A very heavy iron connection might take so much current that the extra flow would be indicated by the amperemeter, but this cannot be relied on, as the load of amperes is constantly changing in any event. On a two-wire system a single ground or iron connection produces no flow of current or bad results whatever, until another ground or iron connection is made on the other side of the circuit, and there is usually opportunity to remove the first ground or iron connection before a second one can occur. With one-wire and a hull return there is damage at once when the first iron connection occurs, and no chance to remedy the faulty contact until the trouble happens.

Under ordinary conditions a contact with terminals of about 110 volts pressure gives but a slight shock to most persons, but with 220 volt circuits, which are now coming into use for lamps and motors, an unpleasant sensation can be had. It is seldom that the user of lamps and fittings on an insulated two-wire system is exposed to a shock, as he must make contact with both wires at some uncovered points simultaneously, but with the one-wire plant a hand laid on an iron part of the ship, while the other is in contact with the wire or a switch will result in a discharge of current through the body.

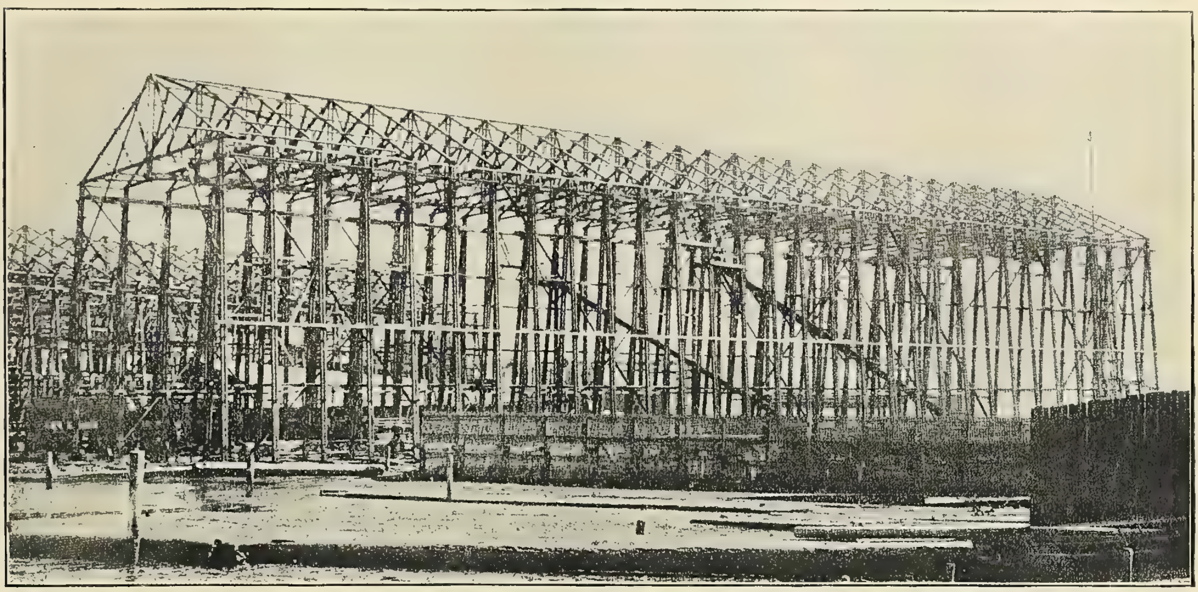
In face of these facts the preference that has grown up for two-wire insulated circuits on ships seems to be well founded.

OVERHEAD CRANES, STAGING AND RIVETER-CARRYING APPLIANCES IN THE SHIPYARD.*

BY JAMES DICKIE.

The need of some means whereby materials can be hoisted and deposited in any position on a vessel, while building, has long engaged the attention of the shipbuilder, and now that power-riveting is coming greatly into use, the demand for something overhead becomes imperative. Added to this is the staging necessary for the construction of the vessel, which is, of itself, a large item in the cost; while to this must be added the necessity of keeping the upper works fair while in the early stages of construction.

These four items form a large portion of the cost of the large merchantman or war vessel, either of the cruiser or battleship type, and when we take into account the enormous beam of these large vessels we find that anything done must be on a large scale. If, then, some kind of a structure that will facilitate the performance of these four functions can be made, we have at least advanced one step towards cheapening the cost of the modern vessel.

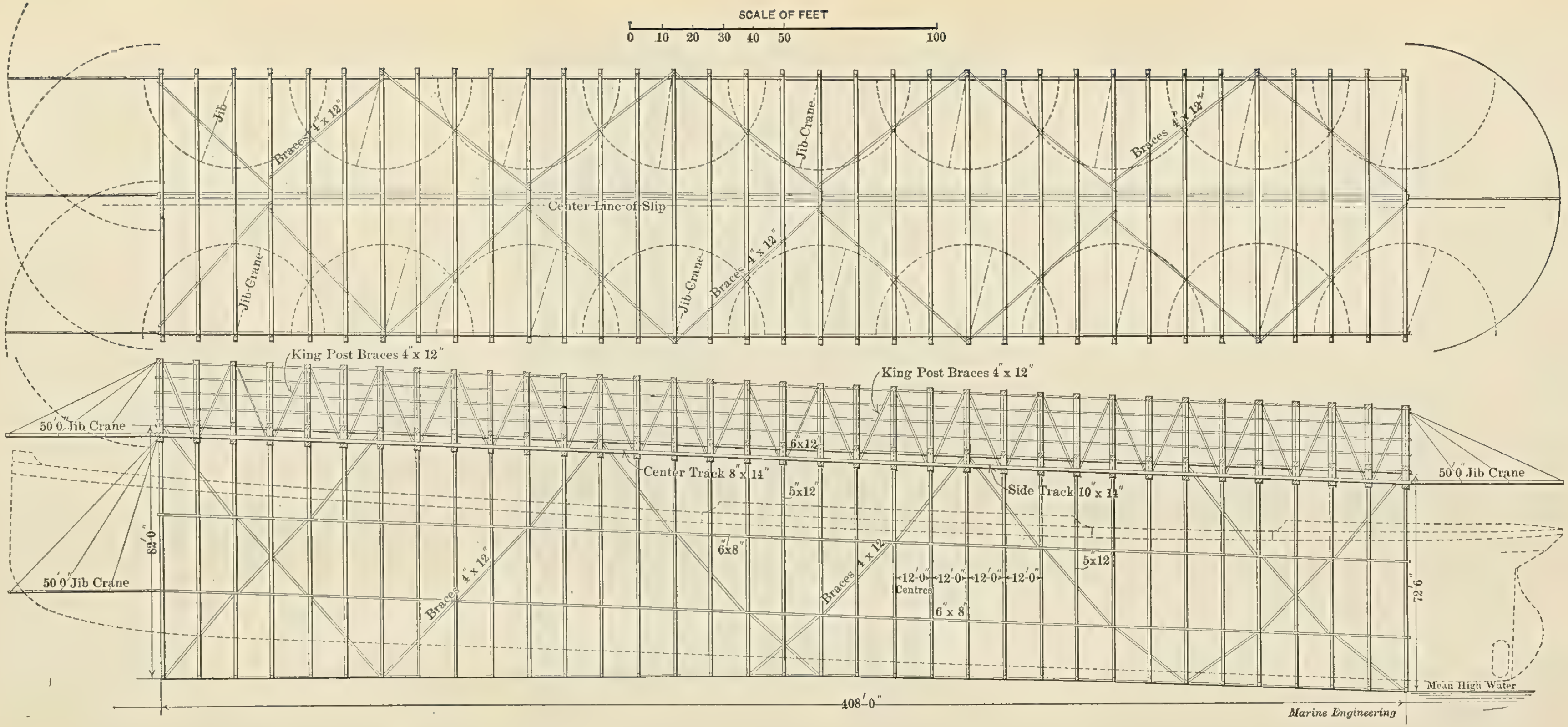


WOODEN FRAMEWORK OVER SLIP NO. 4 IN SHIPYARD OF UNION IRON WORKS, SAN FRANCISCO, CAL.

Previous to 1884, so far as the writer knows, the only means used to hoist materials on a vessel while building was the derrick-pole with the swinging-gaff. Since that time several forms of cranes have been adopted.

1st. We have the cantilever traveling crane, a good example of which is seen at Newport News. This crane has been so often described and illustrated that I need not do more than refer to it. It only performs one of the four functions sought, namely, the hoisting of materials, and as there is only one crane to two ships, the writer cannot see how it can do all the hoisting for one vessel, no matter how fast it travels, seeing that the time of hoisting and traveling is such a small part of the work. We find that the average hoist takes about 40 sec., traveling to the destination about 45 sec., while

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.



PLAN AND ELEVATION SHOWING STRUCTURAL MEMBERS OF THE FRAMEWORK OVER SLIP NO. 4 AT THE SHIPYARD OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.

it takes from 7 to 12 min. to get sufficient bolts in a shell-plate or beam to enable the crane to be let go. At the Union Iron Works we often have to run half an hour to an hour in the evening (with two cranes to one ship) to get all the materials in place.

2d. The overhead crane or gantry, so much used on the lakes, which travels all over the vessel, with rails on the ground on each side. As all the vessels on the lakes are built broadside to the water, two cranes can be used to hoist the material for one vessel, and simply moved to the end when the vessel is launched; but they can only do the hoisting.

3d. The large gantry at Belfast, lately constructed, and used in the building of the *Oceanic*. The writer has seen all the others in operation, but has not seen this one. It appears to perform two of the functions sought, namely, hoisting and carrying riveters; but, judging from the cuts of it, it must be somewhat limited in its operation, as it cannot cover more than 120 to 150 ft. in length of the vessel at the same time, which appears to be insufficient, while such a large and heavy crane must be slow in its motion.

4th. The framework which covers the entire vessel while building. Of this form we have two examples, namely, those at Swan & Hunter's yard, on the Tyne, and those at the Union Iron Works in San Francisco. As both of these perform the four functions, although slightly different in detail, a description of one will be sufficient. The writer, having superintended the construction of those at the Union Iron Works, is thoroughly familiar with all the details, and thought that the publication of them might be interesting to the members of this Society.

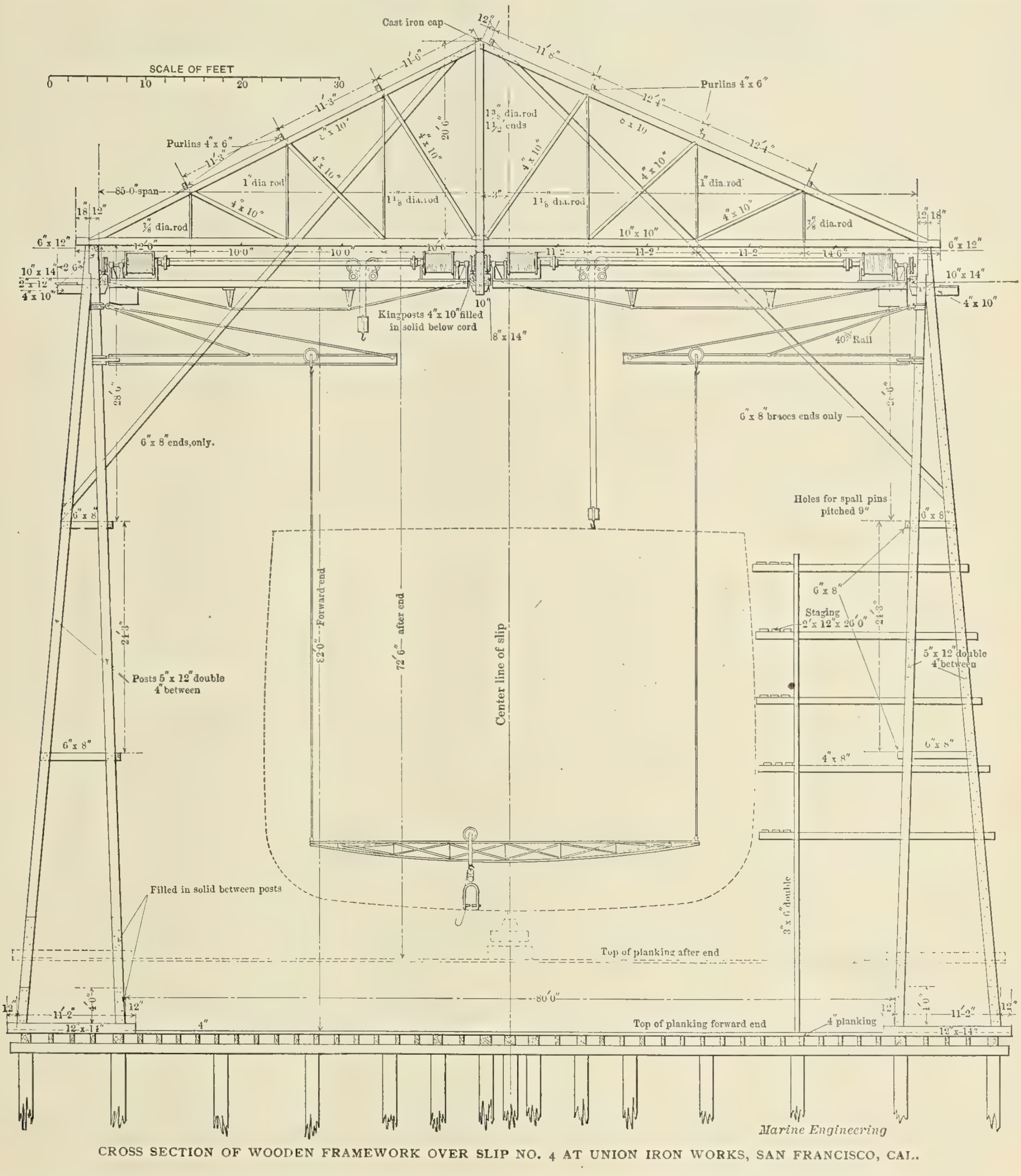
No. 1 was built, in 1884, of timber, as are all the others. It is 300 ft. long, 48 ft. wide, with an average height of 55 ft.; the top being built at an angle of 1 in 24, sloping towards the water. At the lower end is fitted a swing crane 35 ft. long.

No. 2, built in 1887, is also 300 ft. long 85 ft. wide and 58 ft. high, with a swing crane 40 ft. long at each end.

No. 3, built in 1891, is 300 ft. long, 85 ft. wide, 61 ft. high with a swing crane 45 ft. long at each end.

Slip No. 4 is covered with a framework similar to the others, but larger; being 408 ft. long, 85 ft. wide, the height being sufficient to cover the largest vessel. The apex of the roof is 3 ft. from the center, making one crane 6 ft. longer than the other. This is done to enable pieces such as beams, etc., to be landed on the center line.

The cranes are electric and travel at the rate of 180 ft. per min., fore and aft, 90 ft. crosswise, and the



CROSS SECTION OF WOODEN FRAMEWORK OVER SLIP NO. 4 AT UNION IRON WORKS, SAN FRANCISCO, CAL.

average height 78 ft. It was at first intended to make the structure of steel, but owing to the present high price and scarcity of material, it was decided to make it, like the others, of wood. There is a crane at each end 50 ft. long, thus covering a vessel 500 ft. long; and should longer vessels be built in it it can be easily lengthened, hoist 90 ft. per min., with a lifting capacity of 5 tons. A manila rope is used for hoisting, which gives considerable elasticity, and enables a plate to be bolted up if within an inch or two of the place. For plating under the bottom and under the counter we use a wire rope, rove through the plate and the corresponding hole in

the frame and toggled under the plate, which enables the plate to be drawn close up to its place.

One feature of the structure is the facility with which staging can be erected. Where the ship is large, the spauls, which are 4 by 8 in., are rove through the main posts and held by loose bolts at the ends. Where the vessel is narrower, a standard made of 3 by 6 in. double is set on top of the ground, and held from canting by the rigidity of the spaul in the posts, thus saving all bracing. As the posts are all 12 ft. centers, we use 2 by 12 in. by 26 ft. plank for staging, which we find strong enough for any work, and light enough to be easily handled.

We propose, in our new slips, to fit up cranes for riveting as shown in the section. These cranes are made of 8 in. T-bulb beam, and supported by two suspension rods. The trolley for the riveter runs on the lower flange of the beam; the wheels being 20 in. dia. makes it very easily moved.

The machines we are at present using are the toggle-jointed air machines, which drive 7-8 in. rivets with a 30 in. gap. The weight of the machine is about 1,400 lbs. It moves so easily that the operator has no difficulty in making the nicest adjustment. We are also using the percussion air machine, with a 4 or 6 ft. gap, which weighs only about 250 lbs. The cranes for riveting are only 32 ft. long, with a beam hung from them. This enables us to do hoisting and riveting at the same time, as all the material is hoisted up over the vessel and carried along near the center line to a point opposite to where it is to be landed. This center cross beam can be raised or lowered to suit the work on the vessel. When working on the inner bottom it will be down as shown; when on deck it will be close up to the cranes.

We have studied all the various overhead cranes and claim for this structure that it is no more expensive in first cost and fiulfills more functions than any other, except that of Messrs. Swan & Hunter, on the Tyne, and in comparison with it I think we have the advantage in staging. We find no disadvantage in having the posts as close as 12 ft., all the hoisting being done at the upper end, then carried over the vessel to the required place, and, when there, lowered into its proper place. As we use no side shores above the bilge, the top sides are always clear for lowering a shell plate into position, and, as I said before, the bottom plates and plates under the counter are hoisted from the ground with a wire rope rove through the corresponding hole in the frame, and toggled outside the plate; thus the entire plating can be put on the vessel with these cranes. We have two cranes at the upper end of the structure. These we use for frame riveting and all other pieces that can be riveted before going on board. As mentioned before, we use this structure to keep the upper works of the vessel fair while in the early stages.

Looking at the plan you will notice a large amount of lateral bracing on the lower member of the roof trusses, which makes the structure quite rigid.

Two Russian admirals and a number of other Russian officers of high rank are reported to have been arrested at Sebastopol on account of financial irregularities in the construction department at the dockyard there.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATÉRIEL.—IV.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

The war with Spain was too short to give a chance for great experience in any line, but the work of the *Oregon* stands out as a brilliant illustration of the fact that the modern battleship is not only the creature of the engineer, but is absolutely dependent upon him for success. You all know the story of Milligan's work as the chief engineer of the *Oregon;* of his ceaseless vigilance to keep everything in order and prevent any deterioration; of how he saved the good coal for the day of battle which finally came (though he was told it never could come), and, above all, how he persuaded Clark, the commanding officer, to have *all* the boilers ready all the time, although others had steam on only half the boilers, and, where it could be done, half the engine power was laid off. I am firmly convinced that the brilliancy of the victory at Santiago is largely due to Milligan's skill and foresight, and, as I said, this case is direct proof that however admirable as a great fighting machine, the battleship is useless except in the hands of trained engineers.

During the last fifteen years naval engineering has shared in the general progress of all marine engineering, and has led in many respects. Wrought iron, which was formerly the mainstay of the designer, has practically disappeared, to be succeeded by mild steel, which is not only stronger but much more reliable, and the manufacture and inspection of which has been brought almost to perfection. There is little doubt that the great improvements which have been made in both engines and boilers would have been impossible but for the greatly improved material. One of the greatest improvements has been in the reduction of weight of machinery, and this has been due both to improved material and to radical changes in design.

In the engine there has been a better disposition of the material; and the use of hollow instead of solid shafting and other large pieces of forged material, the use of steel castings, etc., has been instrumental in enabling the use of higher pressures, and particularly of higher rotative speeds. These rotative speeds have become possible since we have learned to design the propellers on rational principles. In the old days, as you are well aware, the rule was to make a propeller as large as possible, consistent with immersion, and this, on account of the empirical rules for the ratio of pitch to diameter, necessarily kept down engine speeds. Now we know that within reasonable limits we can design a propeller to suit almost any engine speed; consequently, we are left free to adopt as high a rotative speed as is desirable and consistent with safety, assured that we can afterward design an economical propeller to fit it.

In the boilers, the reduction of weight has been due, apart from the more recent adoption of the water tube type, to improved material, and especially to forced draft. This, as you are doubtless aware, is an Ameri-

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*President's address (1899) at New York meeting of American Society of Mechanical Engineers.

can invention almost contemporaneous with Fulton's early steamers; but it had almost disappeared, and after a brief revival under Isherwood during the civil war, had again died out until it was taken up in some of the foreign navies. At the present time no naval machinery is ever designed without the use of forced draft.

Pressures have been gradually rising, and even with shell boilers as high a pressure as 200 pounds has been employed; but with the present plans of using 250 pounds at the engine, with either triple or quadruple expansion, and some 25 or 50 pounds more at the boilers, nothing but the water tube boiler would do.

At the present time it seems as though we had practically reached the highest development possible with existing types of machinery for naval purposes, leaving the designer room only for greater perfection in details. We do not, of course, believe that finality has actually been reached, and it is possible that some radical change may take place which will give us a new type of machinery. Some of the more enthusiastic members of the profession think that the steam turbine is to be the successor of the present steam engine, and assuredly the performance of Parsons' *Turbinia* is sufficiently remarkable to justify the most careful study and further experiment. It is very interesting in this connection to know that in this country the development of the steam turbine is in the hands of one of our famous engineers, who is also one of the honorary members of this Society—George Westinghouse. He has been developing the steam turbine with special reference to its use in driving electric generators, and some of the results already obtained are very remarkable. With his characteristic energy and courage, he is not satisfied with results on a small scale, but is now getting out a steam turbine to develop about 2,000 horse-power on a single shaft, and when this has been built and thoroughly tested we shall be in a position to appreciate more thoroughly the bearing of this form of prime mover on naval engineering.

At the beginning of this address it was remarked that this was a peculiarly appropriate time for discussing the personnel of naval engineering, on account of the radical change which took place this year in the status of the engineer officers of our navy. For many years, as you all know, there had been an unfortunate controvery in our navy, known as the "line and staff fight," resulting from the fact that the line officers, as the older organization, were unwilling that the staff, and especially the engineers, should have all the rights to which the latter believed themselves, as naval officers, entitled. The great grievance of the engineers was that they held what was called "relative rank" and were denied the command of their men and a military title, so that there was always room for the statement, which unfortunately was made at times, that they were not really officers and had only a quasi rank. All men who have passed middle age have probably realized personally the difficulty of bringing about any radical change in existing conditions of long standing, and I really believe that the trouble in the navy was largely a matter of inertia. An enormous amount of valuable effort was wasted on both sides; the one to secure the coveted rights, the other to prevent this result; but matters had been shaping themselves for a considerable time so as to make a new state of affairs inevitable. The change in the means of offence on board ship had brought the line officer to the point of realizing that he must, of necessity, be a good deal of an engineer, and such work as the manufacture of guns, which is, of course, purely mechanical engineering, showed this very strongly. On the other hand, the work of the naval engineer on on board ship, which had originally been to direct a very few men with small machinery, has been gradually changing, until, on some of our large ships, the chief engineer commanded in fact, although not in name, about half the crew; consequently, his duties had become very largely executive and military, and thus of the same nature as the duties of the line officer. As a result of this state of affairs, many of the more liberal minds on both sides believed that the solution of the vexed question in the navy was the consolidation of the line and engineer corps, and making the new line officer an engineer as well as a sea warrior; or, as Congressman Foss expressed it, a "fighting engineer."

A board of naval officers, presided over by Colonel Roosevelt, then Assistant Secretary of the Navy, finally formulated a scheme for carrying out this idea of amalgamation, which was actually proposed in the board by a line officer (Captain Evans). When it was submitted to Congress, two members of the House Naval Committee, Hon. George E. Foss and Hon. A. G. Dayton, took up the measure very actively, and with the assistance of other members of the committee, pushed it forward to complete success, until the Personnel Bill became a law, March 3, 1899.

Under the provisions of this law the officers of the Engineer Corps were transferred to the line and given new commissions as line officers with *actual* rank, thus effectually disposing of the phantom of *relative* rank. I wish particularly to emphasize the fact that the basis of the law, and the consideration that led to its adoption, was the demonstrated fact that to have a successful navy every line officer must be a thorough engineer. This was very well phrased by Colonel Roosevelt in his report of the findings of the Personnel Board, where he said, "every officer on a modern war vessel whether he wants to or not, must in reality be an engineer." Mr. Foss, in his report to the House recommending the passage of the bill, used language of the same import, and elaborated the matter still further, and in the speeches on the floor of the House this was the subject which had most weight, and which brought about the passage of the measure.

A natural inquiry on your part will be, how successful is this measure in actual practice? To this the answer is that any such change must, of necessity, require time, and it is too early yet to speak of results. I wish, however, to put on record my opinion that if the administrative details necessary to carry the law into effect are worked out with an honest desire to give due effect to its plain intent, and with a desire to make it a success, the results will be all that can be wished, and we shall have the most efficient navy in the world. If, through any unfortunate combination of circumstances, which, however, I can hardly believe possible, there should be any temporary indif-

ference or opposition on the part of those in authority, the result can only be lack of efficiency and disaster in case of war until the intent of the Personnel Board and Congress is put into working effect.

It may occur to some who have only looked into the matter hastily that this scheme of amalgamation is contrary to the spirit of the age, with its tendency toward specialization; but, as an actual fact, the reverse is true. The misapprehension comes from a failure to thoroughly consider the case. When it is proposed to make every naval officer an engineer, we mean an engineer specially fitted for the work to be done in the navy, just as the other training of the line officer is for the duties which come specially to him; in other words, this new line officer—the "fighting engineer"—is to be a specialist in the very best sense of the term; that is, a man who has been specially and thoroughly trained for the work he has to do.

I think we may all feel a pardonable pride in this change in the status of our naval engineers. The amalgamation is analogous to that which occurred in the British navy just after Cromwell's time, and the analogy is not a fanciful nor forced one, but is strictly accurate. Up to the time of that change, naval vessels were manned by soldiers who did the actual hand-to-hand fighting, but were entirely ignorant of seamanship and another set of men who managed the propulsive power of the vessel, which was then the wind acting on the sails, and who directed the movements of the vessel. These men had no military rank, and were designated simply by professional titles, being known as "the sailing-master and his mates." The amalgamation which then occurred was of the soldier and the sailor, and out of this amalgamation was evolved the man-of-warsman and the naval officer. With the advent of mastless ships, we had reached an analogous condition where one set of people fought the guns and another set managed the propulsive power, this time steam acting through machinery. The new amalgamation has made a new naval officer, "the fighting engineer," to be followed in time by the successor to the old man-of-warsman, who will be the "fighting mechanic." The basis of the new amalgamation is the fact that in this industrial age engineering and mechanical skill are the source of efficiency in our navy, and this, as I have said, is a pardonable cause of pride to all of us as engineers.

In the past, engineering has been hampered at times in our navy on acount of the subordinate position which its representatives held in the naval organization; but in the future, as the whole body of naval officers will be engineers, we have every reason to anticipate an era of progress and efficiency greater than has ever been known in the history of navies.

This address has grown to a length which I hardly anticipated when I began, and for which I ask your indulgence, trusting you will agree with me that the importance of the subject and the opportunities of the occasion excuse the extent of the address. We of the old school have lived to see our fondest hopes realized in the proper recognition of our beloved profession before we have actually ceased to participate in its active work. We linger with fond memory over our trials and discouragements, as well as our successes, and we may, perhaps, realize that some of our successes have been due to the stimulus of opposition; nevertheless, it does not make for success that when one is honestly doing his best work he should feel that much of it may be in vain on account of senseless opposition and failure on the part of those in high places to appreciate it and as we older men leave the scene of action and pass on our work to the younger generation, we can congratulate them heartily on starting out under circumstances which are so infinitely better than those of our time, and which give them so much greater opportunity for highly efficient work for the republic.

New Pacific Coast Shipyard.

Another great shipbuilding plant is to be established at the Potrero, San Francisco, within a few hundred yards of the yard of the famous Union Iron Works. It is announced that the new yard will be fully as large, and as well equipped, as any on the Pacific coast, and it is the expressed intention of the promoters of the enterprise to enter in competition for warships and bids on some of the new vessels that will be ordered under the Naval Appropriation bill. The Risdon Iron and Locomotive works of San Francisco is the prime mover in the establishing of this plant, but it is reported that some local capitalist with a standing, such as John D. Spreckles or Claus Spreckles, is interested with the present stockholders.

The Risdon company has at present a large plant, at the corner of Howard and Beale streets in San Francisco, where it turns out mining and marine machinery. The corporation has frequently contemplated going into the business of shipbuilding, but the cost of building material and active competition of local shipyards prevented an investment in water front property. Recently, however, conditions have changed. Every shipyard on the coast has been busy. Orders have even been refused, and, as an additional incentive to prospective investors in shipbuilding plants, the railroad companies have made concessions in the matter of freights that have made it possible for the coast shipbuilders to compete with eastern firms.

President W. H. Taylor, of the Risdon works, is said to have been responsible for the origination of the present scheme to enlarge the field of operation. Several difficult problems confronted him when he first broached the subject to the stockholders, and principal among these was the inability of the corporation to secure a site for the proposed yard, at a point near the San Francisco water front, where extensive dredging would not be necessary for a basin.

The old Hunter's Point Drydock site was taken into consideration, but it was found that it would be impossible to acquire this property, as the Drydock company had reported progress in business and had finally decided to put in a new dock, much larger and more modern than the one now in use. About this time the Pacific Rolling Mills, an extensive concern controlling a fine water front site in South San Francisco, went out of existence as a working concern. Cost of labor on the coast and eastern competition—aided by cheaper labor and much cheaper fuel and raw material—made the output of the rolling mills very difficult to turn out

with profit to the company. The men were finally discharged and the works closed. Shortly afterwards, it is reported, the Risdon company secured an option on the property. Recently, it was turned over to them, but the price paid for it has been kept a secret.

The Pacific Rolling Mills are situated at South San Francisco on the Potrero Point, a splendid site covering thirty-five acres of ground, and controlling a water frontage of 17,000 ft. There is much valuable machinery already on the ground. A large drydock will be built and all necessary machinery of the most improved types will be purchased. Work may commence on the new yard July next, but the management of the Risdon Works is not as yet prepared to make any definite statement on this subject.

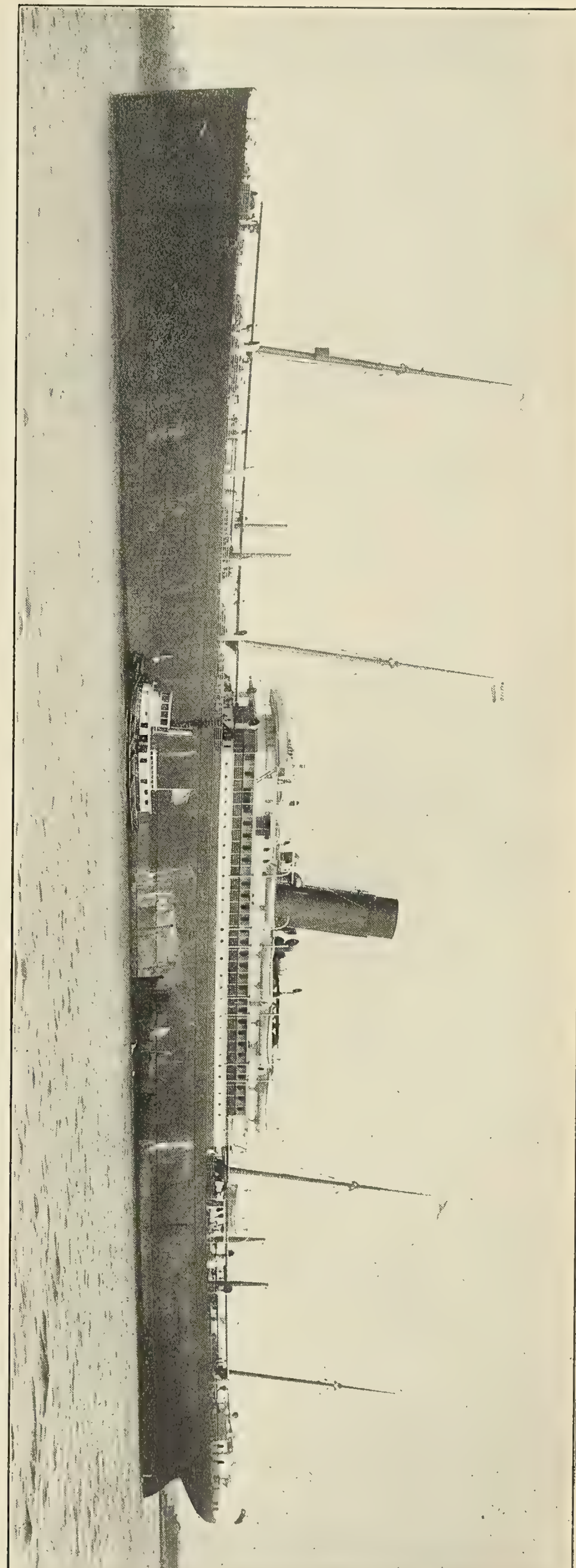
Atlantic Transport Liner Minneapolis.

Another of the modern leviathans of the deep arrived in New York harbor last month on her initial ocean voyage. The vessel was the *Minneapolis*, of the Atlantic Transport Line, in ballast from the yard of the builders, Harland & Wolff, Belfast, Ireland. She is, we believe, the third largest vessel now flying the British flag, those of greater tonnage being the mail steamer *Oceanic*, of the White Star Line, and the intermediate steamship *Ivernia*, of the Cunard Line. The latter vessel, described in our issue of February last, completed her maiden trip to New York last month, a few days after the *Minneapolis* had sailed for London.

The *Minneapolis* is one of four ships of like dimensions ordered for the Atlantic Transport service, the other vessels being the *Minnehaha*, *Minnetonka* and the *Minnewaska*. She is of the following dimensions: Length between perpendiculars, 600 ft.; beam, 65 ft.; depth, 44 ft.; gross tonnage, 13,401 tons; net tonnage, 8,651 tons. Though her dimensions are greater than those of the *Ivernia* her tonnage is slightly less.

The *Minneapolis* is of the same general type of vessel as the *Cymric*, of the White Star Line, or the *Pennsylvania*, of the Hamburg-American Line, all three vessels being products of the same yard. She has the usual long bridge structure amidships, in which all the living quarters and passenger accommodations are placed. Only one class of passengers is carried; there being accommodations for 228 first cabin.

The twin screws are driven by quadruple expansion engines, with cylinders 30 in., 43 in., 63 in. and 89 in., by 60 in. stroke, of the regular Harland & Wolff pattern. Steam is supplied at 214 lb. pressure, and the designed I. H. P. is 10,000. A trial speed of 17 knots was reported. There are five steel decks and as many collision bulkheads. In addition to the cargo space there is accommodation under the shelter deck for about 800 head of live stock. When loaded ready for her return voyage the *Minneapolis* drew nearly 32 ft. of water.



ATLANTIC TRANSPORT LINE TWIN SCREW CARGO AND PASSENGER S. S. MINNEAPOLIS, PHOTOGRAPHED ON HER ARRIVAL AT NEW YORK ON HER FIRST TRIP OUT.

WAGES PAID MECHANICS IN THE PRIVATE SHIPYARDS OF FOREIGN NATIONS.

In considering questions of vessel construction from a competition standpoint the prevailing rate of wages paid in private yards of the various shipbuilding nations is of much importance. So far as material is concerned our own yards had an advantage over those of foreign countries before the recent "boom" sent structural steel away up, and for a time, at least, brought back the old conditions. The advance, however, is not likely to be permanent, and when the rush is over prices will undoubtedly fall.

This question of wages in shipyards has been in part the subject of an extensive investigation by the U. S. consuls abroad under instructions from the Department of State at Washington. Their several responses have been embodied in a special consular report on the "Merchant Marine of Foreign Countries," just issued. The queries were addressed to the consular officers of the United States, the chief purpose being to procure accurate information concerning the carrying trade of each maritime country. Among the inquiries was one asking what was the average weekly wages of men engaged in the various construction branches in shipyards, a list of occupations being given. For this reason the information secured is in most cases confined to a limited number of trades or occupations. Probably very few of the consuls have much familiarity with ship construction, and so, in making inquiries, they did not go beyond the letter of the instructions, and for these reasons the information is not as complete as might be the case had the investigation been conducted by experts. What there is, however, is accurate and authoritative and of very great value. In the accompanying table we have gathered together the figures for the various countries, which are scattered throughout the report, so that they admit of more ready comparison. In many cases it will be possible to supply omissions by estimate, a sufficient number of different occupations being covered to give a line on the situation in general.

It will be noted in reading the table that not all of the returns give the average *weekly* wages, in some cases the rate by the *hour* and by the *day* being given.

Besides the figures in tabular form the various reports contain memoranda which are helpful to a proper interpretation of the figures, and in some cases are worthy of careful reading by manufacturers of shipbuilding materials, fittings and apparatus of various sorts.

TABLE SHOWING AVERAGE WAGES PAID WORKMEN IN THE PRIVATE SHIPYARDS OF

Country	Rate of Wages	Blacksmith	Boiler Makers	Cabinet Makers	Calkers	Coppersmiths	Drillers	Fitters	Furnacemen	Joiners	Laborers
AUSTRIA—											
Trieste	Dollars per week								4.87—6.09	4.06—4.87	2.84—3.65
CANADA—											
Toronto	Dollars per day								1.75	2.00	1.00—1.25
Halifax	Dollars per day									2.25	1.25—1.50
DENMARK—											
Copenhagen	Dollars per week					10.18—10.72					
*FRANCE—											
La Seyne	Cents per hour								17.37	11.58	8.69—10.52
GERMANY—											
Bremen	Dollars per day		.87		.85		.70		.78		
Stettin	Dollars per day		.75—1.25		.60—.80		.75—1.00		.75—1.00		.60—.70
Hamburg	Dollars per week								7.14	9.52	3.33—6.66
Kiel	Cents per hour								8—9	9	6—7
**ITALY—	Dollars per week								6.00—14.50	5.00—7.00	2.50—3.50
†JAPAN—											
Nagasaki	Cents per day		75			62.5		75	35		25
††NETHERLANDS—											
Amsterdam	Cents per hour									8.8	6.4—6.8
UNITED KINGDOM—											
§Barrow-in-Furness	Dollars per week								6.32	9.30	4.38—5.83
Belfast	Dollars per week								10.94	8.76	4.38—5.11
Glasgow	Cents per hour		18	17—19				16		17	11
Glasgow	Dollars per day										
‖‖Glasgow	Dollars per week	6.56									
Liverpool	Dollars per week								5.59	9.11	4.86
¶London	Dollars per week								6.08	9.61	4.38—5.82

* At Marseilles the average wage per day is 96 cents to $1.35, depending more on individual merit than on the trade. Laborers receive from 57 cents to 67 cents per day. The French working day is ten hours.

** Wages are less in Central and Southern Italy than in the North. † Productive capacity of workmen is very low.

†† On work given out on contract, the workmen receive on the average 20 per cent higher wages.

Austria—The consul at Trieste writes that the principal materials used in shipbuilding are produced in Austria, but considerable quantities of metal have been imported during the past few years, and these imports are on the increase. A few mechanical accessories are almost exclusively imported from England. The current price of Austrian steel ship plates is 100 to 110 florins ($40.60 to $44.66) per 1,000 kilograms (2,204.6 lb.). Bounties are granted by the state for the construction of both sailing ships and steam vessels, and by a recent law all ships are exempted from taxation for another five years.

Belgium—At Antwerp work is let out by job or piece work, by contract, wages varying from 15 cents for boy apprentices to $1.25 a day for workmen. Little new work is done, and all structural steel used is of domestic manufacture.

Canada—Vessel construction has fallen off enormously since the substitution of metal for wood. In the year 1868, one year after confederation, Canada built a total of 87,230 tons of new ships, and last year less than one-quarter of this tonnage was put out. In 1876 Canada built ships for other countries of the value of $2,189,270, while last year her output for foreign owners amounted to only $191,069. In his report the Consul General at Montreal says that Canadian steel making interests are likely to reach gigantic proportions during the next ten years, and there are indications that shipbuilding will develop simultaneously with the iron industry. Present movements in this direction cited are the establishment of a steel shipbuilding plant at Hamilton, the increase of present facilities at Toronto, the construction of a dry dock and preparations for a yard also at St. John, N. B., and the plans of the Dominion Iron & Steel Co. at Cape Breton, which contemplate the establishment of an extensive plant at a future date. No bounties to assist shipbuilding are granted in Canada, but on steel billets and bar and pig iron there is a bounty which is indirectly of aid to shipbuilders. At present all steel plates and shapes are imported, the bulk formerly from Pennsylvania at 2 1-4 cents a pound F. O. B. cars at the mill. Now English ship plates are delivered in Canada for $2.12 1-2 per 100 lb.; 5-16 in. plate, $2.16 1-2 per 100 lb.; 1-4 in. plate, $2.20 per 100 lb., and shapes $2.50 per 100 lb.

Denmark—Structural material for ships is imported from Germany, Great Britain and the United States. During 1899 the average price for steel plates was $35.23, cost, freight, and insurance, Copenhagen.

France—For a number of years the Government has given much attention to the merchant marine. By the act of 1893 the bounty for construction was placed at $12.54 per gross ton for vessels, and $2.89 1-2 per 220 lb. for machinery and boilers. Most of the French yards are so occupied with naval work that private owners have to wait a long time to get orders filled. Thus a vessel which could be delivered from an English yard in nine months would, in a French yard, take twenty or thirty months to build. The principal materials used in the construction of vessels are of domestic production, though due to the great demand for steel for other purposes and to the cheapness of certain classes of foreign shipbuilding material, the builders make extensive importations, chiefly from England. The price for ship steel at Havre is quoted at $58 per ton, and at Marseilles, $46.30 per ton. At the latter port the wages of shipyard mechanics range from 96 cents to $1.35 a day of ten hours, the rate depending more on individual skill than on the trade. Laborers get 57 cents to 67 cents a day. Overtime counts as time and a half to double time. In the Government dockyards at Toulon the men are divided into four classes, with wages ranging from 12 cents to $1.31 a day. After 25 years of service and 50 years of age an annual pension is granted, ranging from $102.29 to

FOREIGN NATIONS.—COMPILED FROM SPECIAL (OFFICIAL) REPORTS OF U. S. CONSULS.

Loftsmen	Machinists	Moulders (Brass.)	Moulders (Iron.)	Painters	Pattern Makers	Platers	Plumbers	Riggers	Riveters	Sheet Iron Workers	Ship Carpenters
....	4.87—6.09	4.87—6.09	4.87—6.09	3.65—4.87	4.87 to 6.09	....	4.06—4.87	4.47—5.68	6.09—7.31	4.87—6.09	4.87—6.09
....	1.75—2.00	2.25	2.25	1.75	1.75—2.00	....	2.00—2.50	2.00	1.90—2.00	1.75—1.90	1.75
....	2.50 3.00	....	2.00—2.25	2.00	....	....	....	2.25—2.50	3.00	1.75—2.00	2.50
6.97	8.04—10.18	....	8.04—8.58	12.32	8.58—10.18	....	8.84—9.65	8.84	8.30—8.86	9.11—9.63	....
....	11.58—12.55	....	....	11.58—15.44	17.37	....	....	15.44—17.37	13.51—15.44	13.51	14.48
.80	.85	....	.83	.90	.71	....	.73	....	.85	.94	1.00
....	.75—1.25	....	.65—.85	.70—.85	.75—1.00	....	.60—1.00	....	.60—.80	.70—.85	.75—1.10
....	12.37	6.66—7.14	6.66	8.57	16.66—19.04	....	7.14	8.57	9.52—10.71	6.66	9.52
....	....	8—8.3	8—8.3	7—9	....	....	7—9	7	10	7—9	7—8
....	12.00—16.00	5.00—18.00	5.00—18.00	....	7.00—9.00	....	5.00—7.00	....	5.00—9.60	5.50—14.00	....
....	75	....	....	37.5	65	....	....	50	....	....	60
....	....	....	....	7.2	8.8	....	....	10	7.6	6.4—8	8.8—10
....	....	8.99—9.48	9.24—10.21	8.75	....	....	9.30	8.02	14.59—18.24	9.36	9.42
....	8.76	8.76	9.73	8.76	8.76	....	8.76	8.76	8.76	9.73	8.76
....	....	20	17.5	13.5—15	17	....	20	....	....	....	....
10.95	....	....	....	....	....	....	....	....	3.65—4.38	....	....
....	7.29	....	....	8.26	9.60	9.73—10.21	8.75	8.75	8.75	....	9.48
....	....	9.37	8.62	8.27	9.73	....	8.76	7.30	14.60—17.03	8.76—9.25	10.58

§ The week consists of 54 working hours. ‖ The week consists of 54 working hours. Draughtsmen receive from $6.08 to $12.16 per week. Hull rivetting is usually sub-let in sections to one man who engages a "squad."
¶ Riveters are on piece work exclusively. Iron moulders on piece work earn about $14.60 per week.

$218.09, and an allowance for widows up to a maximum of $134.14 annually.

Germany—Merchant shipbuilding on an extensive scale dates only from the late eighties. Since 1891 the Government has paid about $2,380,000 as premiums for new ships built, and has for several years granted heavy subsidies to mail steamship lines, and in many other ways has helped build up the German merchant marine. Shipbuilding materials can be imported duty free, and materials of domestic origin are hauled from the manufacturers to the shipyards, by the Government railroads, at the bare cost of handling and transportation.

Italy—Navigation subsidies and construction bounties are paid by the Government. The latter in amount are as follows: Iron and steel ships, $14.86 per ton gross, and wooden vessels, $3.38 per ton gross; engines, $2.41 per I. H. P.; boilers, $1.83 per quintal (220.46 lb.?). Structural material for ships is now manufactured in Italy, and only a small amount is imported. It is duty free. The price of steel plate is $4.63 to $5.40 per 220 lb., depending on the size of plate ordered. The consul at Naples reports that mechanics receive only 30 cents to 60 cents per day, though experts sometimes receive $1.00 a day.

Netherlands—The work of the Government in behalf of the merchant marine is almost entirely confined to police regulations. Payments are made only for the carriage of mails. Steel and iron for vessel construction are imported from England and Germany, present prices being $3.26 to $3.80 per 220 lb., but these prices are advancing. Work in shipyards, so far as possible, is let on contract.

United Kingdom—The British Government does not pursue any particular policy for the purpose of promoting its merchant marine. Subventions are paid for the use of certain vessels as armed cruisers in case of war, and payments are made for the carriage of mails. Practically all structural material is of domestic manufacture, though some large steel castings are imported from Essen. Some of the wood working machinery in use in shipyards is made in the United States. The Consul General at London reports the price of steel delivered in the shipyards as $36.50 a ton for plates and $34.67 a ton for angle and bulb bars. In "depressed times" steel plates have been delivered as low as $23.11, and bars $21.90. The consul at Liverpool states that current prices for steel hull plates run from $37.71 to $41.97 per ton. Prices at Glasgow are given by the United States Consul as follows: Ship plates, $37.10 per ton; boiler plates, $42.58; angles, $35.28; hematite pig is quoted at $17.51 per ton, against $12.65 for the same period in the previous year.* Pine and cedar for decks is quoted at 8 cents to 12 cents a sq. ft., and mahogany for interior finish 12 cents to 26 cents a sq. ft. Teak wood averages 10 per cent higher. Interesting details of prices of vessels are given. The Cunarders, *Campania* and *Lucania,* 12,950 gross tons, cost about $2,435,683 each, but could not be built now for anything like that price. Two mail steamers for the Castle line, built at Fairfield, of 10,000 gross tons and 15,000 I. H. P., cost $1,459,950 each. "Other well appointed passenger steamers, with engines to drive them at from 12 1-2 knots to 15 1-2 knots, cost about $97.33 to $121.66 per ton; first-class river steamers cost from $136.26 to $160.59 per ton; coasting passenger and freight steamers from $72.99 to $107.06 per ton, and the usual tramp of from 4,000 to 6,000 tons, $37.71 to $51.09 per dead weight ton." Prices for war vessels run high, according to this schedule: Destroyers, $291.99 per ton; dispatch boats, $267.65 per ton; belted cruisers, $257.92 per ton, and first-class battleships, $243.32 per ton.

In the foregoing attention has been given to the data concerning construction, contained in the document, rather than to operation. In another chapter we hope to again refer to this side of the investigation as disclosed in the valuable consular reports. Prices of material are, of course, subject to fluctuation, and no doubt the figures given are not the market prices now. They permit of close comparisons, however, for all the reports were made out about the end of last year, so that while prices are probably less than those of today the differences between one country and another are probably no greater.

*British prices for material have advanced considerably in the past few months. Recent quotations are: Pig iron, $18.22 per ton; steel ship plates, $40.09 per ton; angles, $39.41 per ton; boiler plate, $46.78 per ton; steam coal, $4.61 to $4.86 per ton; small coal, $3.40 to $3.64 per ton; blast furnace coke, $6.07 per ton. War conditions have also advanced the price of labor.—Ed. M. E.

FAILURE OF A WATER TUBE BOILER DUE TO SHORTNESS OF WATER.*

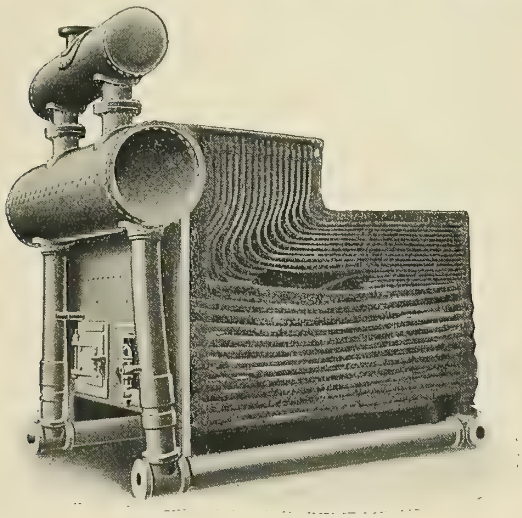
BY WILLIAM F. DURAND.

A few months ago there occurred to the boiler of a tug-boat in New York harbor a most remarkable accident, resulting in apparently melting out a large cavity in the midst of the nest of wrought-iron tubes. The boiler is of the Boyer[1] water tube type, and as shown in the figure consists of an upper drum extending transversely across the front of the boiler and connected by large down-flow pipes to a smaller transverse lower drum at the back. Extending vertically from the lower drum and horizontally from the upper drum are smaller tubes acting as headers, and joining these are the steam forming tubes in elements, each element consisting of a so-called "flat" of tubes connecting a pair of headers. The circulation of water in the boiler is from the upper drum where the feed enters, down through the down-flow pipes to the lower drum and then up through the vertical headers to the steam forming tubes. It then passes through these tubes to the upper horizontal drum where the steam and water are separated, the former passing to the engine and the latter falling to the lower part of the drum and joining the round of circulation again.

On the day of the accident the regular engineer of the boat was sick and was replaced by a substitute. It appears that the preceding night, according to his custom, the engineer had closed the water gauge cocks, thus shutting off the gauge from the boiler, and it would appear that this fact was unknown to, or overlooked by, the engineer of the day. The tug started out with a tow, and nothing at first seemed amiss, until meeting

*From the *Sibley Journal*, Cornell University, Ithaca, N. Y.
[1]For drawings of this type of boiler see March issue, page 125.

with head wind and rough water, complicated by the swell of a passing steamboat, it was found necessary to put on full power to make headway with the tow. The boiler pressure had been somewhat over 100 lb. per sq. in., and the steam jet at the base of the stack was put on. The steam pressure, however, continued to fall, and a suspicion seems to have arisen that something



BOILER WITH CASING REMOVED.

was wrong, though so far as observed the feed-pump had previously been in regular operation. The evidence here is scanty, but the engineer, from one reason or another, apparently became convinced that his water was short, and he therefore started in to haul the fire. He had hardly more than begun when he noticed something dropping down from above into the fire, and shortly after the steam pressure fell to nothing, but without explosion or violence so far as observed.

Subsequent examination showed a condition of affairs as indicated by the cut made from a photograph taken at the time, and after simply removing a side superheating coil the better to show the cavity burned out. Some 200 or more tubes were burned or completely melted out, leaving a clear cavity as shown, the metal formerly composing these tubes having simply melted and run down, mostly into the fire, occasioning the "dropping down" noted by the engineer, though small amounts remained attached to or clogged between the remaining ends of the burnt tubes. The substance thus found on and between the tubes has been kindly analyzed in the Department of Analytical Chemistry, Cornell University, with the result of showing a composition substantially identical with that of the magnetic oxide of iron (Fe_3O_4). To judge by its appearance this substance had plainly solidified from a state of fusion, and at the time of solidification, at least, seems therefore to have had the composition of magnetic oxide of iron rather than metallic iron.

The melting point of wrought iron has been variously estimated at from 3,000 to 4,000 deg. Fah., but in any event it is far above the temperature attainable in an ordinary coal fire, and far above any temperature possible by the heat radiated to the tubes at a distance of 10 to 15 in. above the fire. Furthermore it will be noted that the focus of the action seems to have been within the nest of tubes, the lower tubes next the fire being hardly more than melted through, while some 30 to 36 in. are melted out of those a little way above. There seems, therefore, to have been a development of heat in the midst of the nest of tubes of sufficient intensity to give a temperature of from 3,000 to 4,000 deg. Fah., and for a time sufficient to accomplish the melting of the tubes as shown. The puzzle to be explained is, therefore, the development of a source of heat of such an intensity.

The following are a series of suggestions which may have some bearing on the solution:

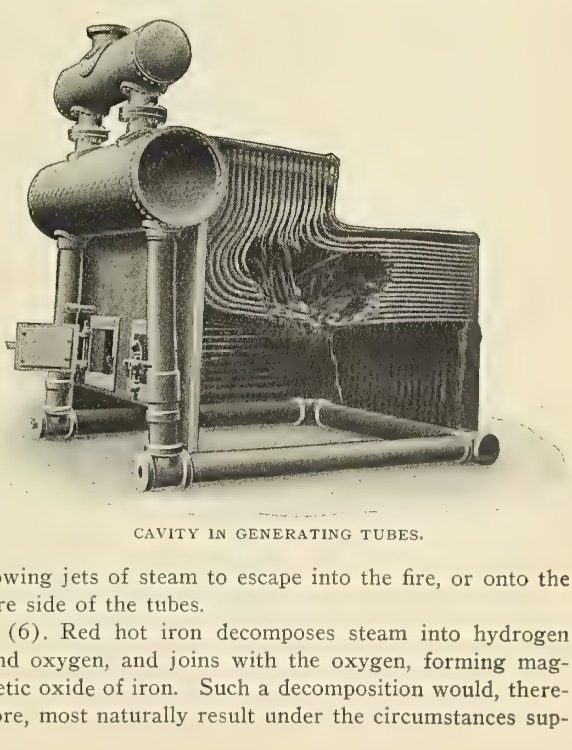
(1). The gauge glass was shut off from the boiler so that its reading had no meaning whatever, and there is no knowing what the level of the water in the boiler may have been at any time.

(2). The general conditions of the service of the boat at the given time indicate a heavy call for steam, and there is no assurance that the feed-pump made good to the boiler the draught of water from it.

(3). From (1) and (2), and entirely independently of the final result, we may assume the probability of low water in the boiler. Again, the absence of any explosion or violent outrush of steam at any time, at least so far as noted by the engineer, indicate that at the instant of rupture the water was just about down to the last drop, and that what small amount of steam may have been in the boiler at the instant the tubes melted was not sufficient to create any great amount of disturbance.

(4). With the low water would come overheating of the tubes, and we may well believe that most of them in the end would become red hot, or nearly so.

(5). The overheating of the tubes would occur while they were still under pressure, and it might naturally result that one or more overheated tubes under such pressure would open out in the welded joint, thus al-



CAVITY IN GENERATING TUBES.

lowing jets of steam to escape into the fire, or onto the fire side of the tubes.

(6). Red hot iron decomposes steam into hydrogen and oxygen, and joins with the oxygen, forming magnetic oxide of iron. Such a decomposition would, therefore, most naturally result under the circumstances sup-

posed to exist. In fact, such a decomposition might already have begun on the inside of the tubes, their temperature very probably having risen to the point where such action would occur.

(7). There may thus have arisen a series of conditions providing a source of hydrogen within the nest of tubes. If now there should come in an excess of air furnishing oxygen in abundance, the hydrogen might suddenly enter into combustion, furnishing practically an oxy-hydrogen flame in the midst of the nest of tubes. The heat thus developed would presumably be of sufficient intensity to accomplish the results noted.

(8). Again, magnetic oxide of iron melts and becomes fluid at a temperature considerably lower than wrought iron, and the first result might be the melting of the oxide previously formed, accompanied by the continued formation and melting of additional quantities. In fact, it seems not unlikely with the action distributed over so considerable a surface that the operation would consist largely of a rapid formation and melting of magnetic oxide, the molten oxide serving as a flux and helping perhaps to bring the iron to a state of fusion. This might explain why so much of the molten product was magnetic oxide rather than metallic iron. In fact, it would probably be very difficult to bring wrought iron into a state of fusion in the metallic state in the intimate presence of oxygen, and we may readily believe that most of the molten result was of the same character as that analyzed.

The combination of events here found—the complete melting of such a mass of wrought iron boiler tubes in the midst of the nest, with no explosion or noticeable disturbance—seems to mark this as an accident unique among boiler casualties. No blame, of course, can attach to the boiler either in point of design or workmanship. Boilers are not intended to work without water, and usually when an occasional attempt is made to operate them in this way the results are serious to life and limb as well as to the boiler itself.

New Lake Passenger Steamers.—A new steamship company for carrying on a fast freight and passenger service on the Great Lakes is projected. Buffalo, N. Y., parties are promoting the scheme, which contemplates a regular service between Buffalo, Cleveland, Detroit, Mackinac, Milwaukee and Chicago. To carry this into effect two combined passenger and freight steamers are to be constructed of these dimensions: Length on keel, 450 ft.; beam, 55 ft.; depth, moulded to main deck, 29 ft. They will be fitted with single screws, driven by triple expansion engines, to give a maximum service speed of 17 miles per hour. Each vessel is to have accommodations for 950 passengers, and is expected to be ready for service in May, 1901. The corporation is known as the Great Lakes Steamship Co., and has offices in the Guarantee Building, Buffalo, N. Y.

On Saturday, April 14, the Paris Exposition of 1900 was formally opened to the public by President Loubet of France. The United States exhibitors are more numerous than those of any other foreign nation, the total number of exhibitors being over 6,500. The United States exhibits cover nearly 330,000 sq. ft. in 47 separate exhibition spaces.

NEW 18,000 TON VESSELS FOR THE PACIFIC MAIL STEAMSHIP CO.

Work is progressing on the two magnificent steamers for the Pacific Mail fleet at the Newport News yard, and in a little more than a year from now, these boats will be ready to contest the transpacific records. These two ships are of the largest size, and will be capable of making a sustained sea speed of 18 knots. Not only indeed will they be the largest and finest vessels on any route in the Pacific trade, but in point of size and equipment they will be in the same class with the best ships in the transatlantic service. The new vessels will be put on between San Francisco and Hong Kong, with Honolulu, Yokohama and Nagasaki as ports of call.

Following are the dimensions of the new vessels: Length between perpendiculars, 550 ft.; length over all, 572 ft. 4 in.; beam, 63 ft.; depth, 40 ft.; draft, 27 ft.; displacement, about 18,600 tons. Accommodations will be provided for 200 first-cabin passengers, 30 white steerage and 1,200 Chinese. Quarters for the latter are arranged so that the space may be utilized for other purposes, if unoccupied by Chinese.

The hulls will be constructed of steel, with frames spaced 32 in. apart throughout. A double bottom extends from stem to stern and is carried up to the turn in the bilge. There are four decks extending the whole length of the vessels, known as the lower, main, upper and promenade decks. In addition to these are the orlop and boat decks.

Below the lower deck are located the orlop decks, engine and boiler rooms, coal bunkers, shaft alleys, chain lockers, trimming tanks and cargo space. Forward of the fire-rooms are water ballast tanks, and aft of the engine rooms, fresh-water tanks. On the lower deck are the store-rooms, cargo space and coal bunkers.

On the main deck are located store-rooms, quarters for white steerage and Chinese, baggage room, coal bunkers, dynamo room, ice machine and refrigerating rooms and the steward's quarters.

On the upper deck forward are seamen's and petty officers' quarters, wash and toilet rooms for Chinese and white steerage, carpenter's and paint shops and lamp room. On this deck are also situated the first-class dining saloon, pantry and galley, staterooms, passengers' toilet rooms, quarters for the engineer's force, freight clerks and electricians, and the donkey boiler in the boiler hatch. Aft are the firemen's quarters, crew's and steerage galleys and Chinese hospital.

The next deck is the promenade deck, on which is located the windlass forward. Amidship are first-class cabin accommodations, arranged in order: Social hall, music room staterooms, passengers' toilet and smoking rooms.

On the boat deck are situated the officers' quarters, armory, chart room and wheelhouse. Above this is the flying-bridge, on which there is a steering gear.

The main engines consist of two four-cylinder quadruple expansion engines of the vertical inverted, direct-acting type placed abreast of each other in separate water-tight compartments. The cylinders are of the following dimensions: H.P. 35 in., 1st I.P. 50 in., 2d I.P. 70 in., and L. P. 100 in dia. with a common stroke of 66 in. The engines are designed to develop 18,000 indicated

horse power, while running at 86 revolutions per minute. The cylinders are arranged in the following order: H.P. forward, L.P., 2d I.P., and 1st I.P. aft. The engine framing consists of cast steel columns of I section, secured to the cylinders and bedplates. The bedplates are also of cast steel. The valves are of the single ported piston type and are of cast iron. The link motion is the Stephenson link type. All the cylinders are steam jacketed. The piston rods are of forged steel fitted with cast iron crosshead slippers lined with Parson's white bronze, which work in cast iron crosshead guides. The connecting rods are of forged steel 138 in. long between center of crank and center of crosshead pin. The pistons are of cast steel and are of the dished pattern. The eccentrics are of cast iron keyed to the crank-shafts. The eccentric rods and valve stems are of forged steel, the former being secured to the eccentrics by composition straps. Each main engine will be fitted with a steam and hydraulic direct acting reversing engine and a 7 in. and 7 in. by 5 in. turning engine.

The thrust bearings will be two in number, of the ordinary horseshoe type, with fourteen shoes to each bearing. The stern tube bearings will be of the ordinary brass sleeve pattern, fitted with lignum vitæ.

The crank-shafts will be forged steel in four interchangeable sections. The thrust, line and propeller shafts will also be forged steel. All shafts will be hollow. From the stern tube stuffing-box to the propeller hub the propeller shafts will have sleeves of composition, to protect against the corrosive action of the sea water. The propellers will be of the three-blade type. The hubs being cast steel and the blades bronze.

There will be two main condensers, one for each main engine. Each main condenser will have an independent air pump and two circulating pumps. The circulating pumps to be operated by a compound engine. Two auxiliary condensers will also be provided with combined air and circulating pumps attached. Two feedwater heaters will also be installed.

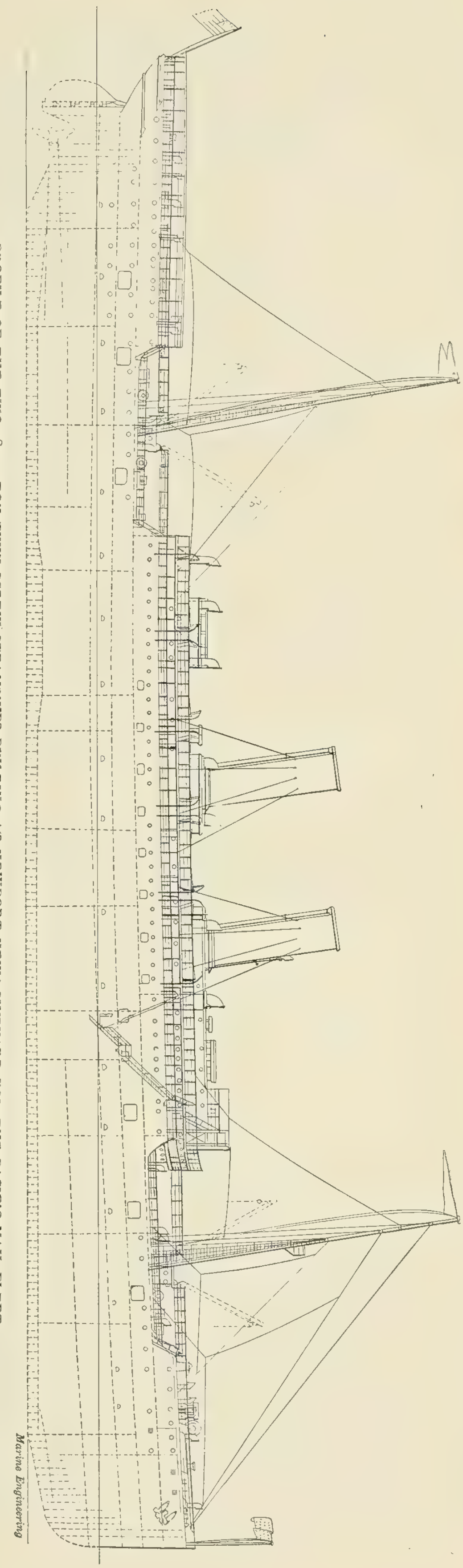
The boilers are to be nine in number, eight main boilers and one donkey boiler, of the horizontal return firetube type. The arrangement of boilers is as follows: One donkey boiler on the upper deck in the boiler hatch. The main boilers placed in a fore and aft direction in two compartments, with all fire-rooms athwartship. In the after boiler compartment two single-ended and three double-ended boilers, and in the forward boiler compartment three double-ended boilers. Following are the principal boiler dimensions:

	Auxiliary.	Main Boilers.	
	Boiler	Single Ended.	Double Ended.
Type	Scotch	Scotch	Scotch
Number	1	2	6
Dia. ext. mean	11 ft. 6 in.	16 ft.	16 ft.
Number of furnaces	2	4	8
Length of grates	6 ft.	5 ft. 9 in.	5 ft. 9 in.
Number of combustion chambers	1	4	8
Tubes outside dia.	2½ in.	2½ in.	2½ in.
Heating surface	1,421 sq ft.	3,208 sq ft.	6,416 sq ft.
Grate surface	44 sq. ft.	76.58 sq. ft.	153.16 sq. ft.
Ratio of H.S. to G S.	32.3	41.89	41.89
Steam pressure	200 lb.	200 lb.	200 lb.

The vessels will be equipped with forced draft. The air will be heated before entering the furnaces and will be supplied by thirteen steam-driven fans.

There will be the following steam pumps for feed and

PROFILE OF THE TWO 18,000 TON TWIN SCREW STEAMSHIPS BUILDING AT NEWPORT NEWS SHIPYARD FOR THE PACIFIC MAIL FLEET.



other purposes. Four main and auxiliary feed pumps, two fire and bilge pumps and two sanitary pumps.

Each vessel will be equipped with an extensive electric lighting plant, also a refrigerating apparatus for the purpose of making ice and to provide means for cold storage. There will also be a distilling apparatus of improved type and design.

In the deck department the steering gear will be steam. Forward there will be a steam windlass and located at most convenient points will be eight cargo winches.

Both the hulls and machinery of these vessels were designed by the builders, the Newport News Shipbuilding and Dry Dock Company and each vessel will cost about $2,000,000 complete.

SCHOONER RIGGED STEEL TOW BARGES FOR DEEP WATER TRADE.

For carrying bulk freight in Atlantic coast service, the tow barge is being more and more employed, owing to the cheapness of this mode of conveyance and the independence of weather conditions as compared with sailing craft. Many of the barges in service are superannuated sailing vessels, or in more than one instance steamers stripped of all their machinery, their fittings, and nearly all their accommodations. These are more or less makeshifts—having the merit chiefly of cheapness—though it is not an uncommon opinion that anything that will float when loaded is good enough to tow.

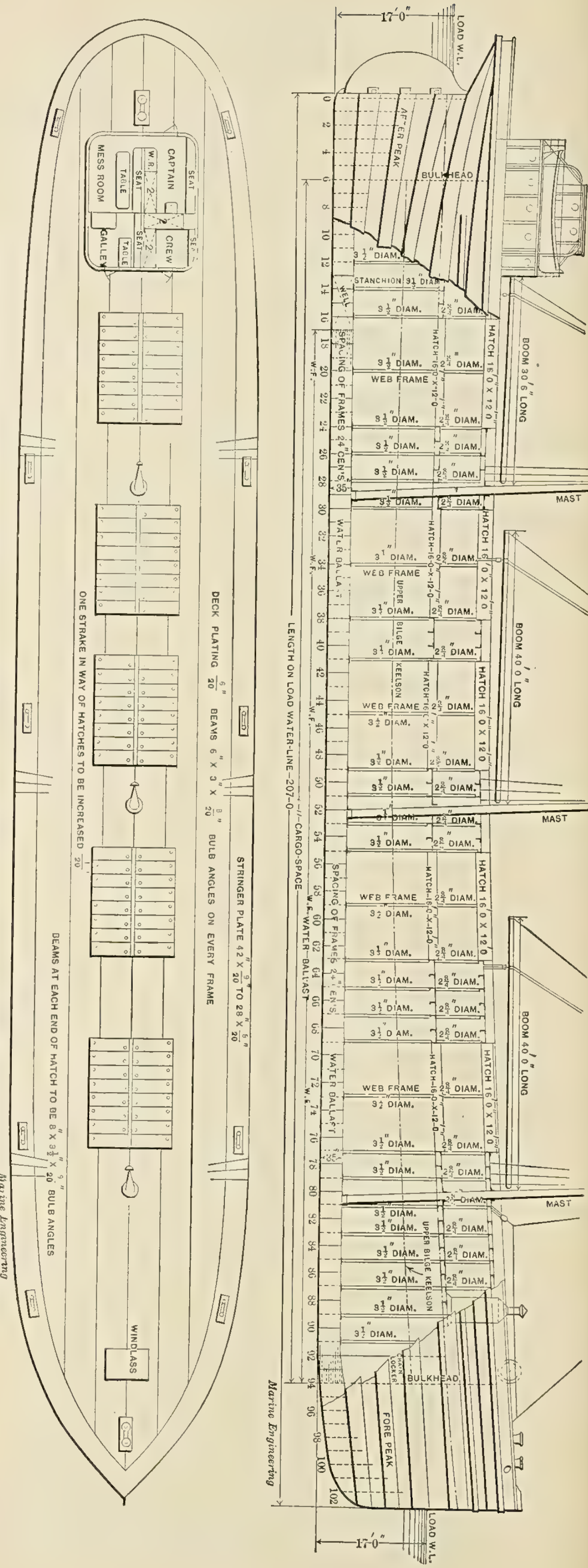
There are, however, examples of good steel construction to be met with in the Atlantic coast trade—vessels designed especially for this service. Of this type are the barges here described. These were built for the J. B. King Transportation Co., Staten Island, New York, by the Burlee Dry Dock Co., of Port Richmond, Staten Island. They are substantial, seagoing vessels, built for towing between the Bay of Fundy and the port of New York, and are designed to carry 2,067 tons on a draft of 17 ft. Their principal dimensions are:

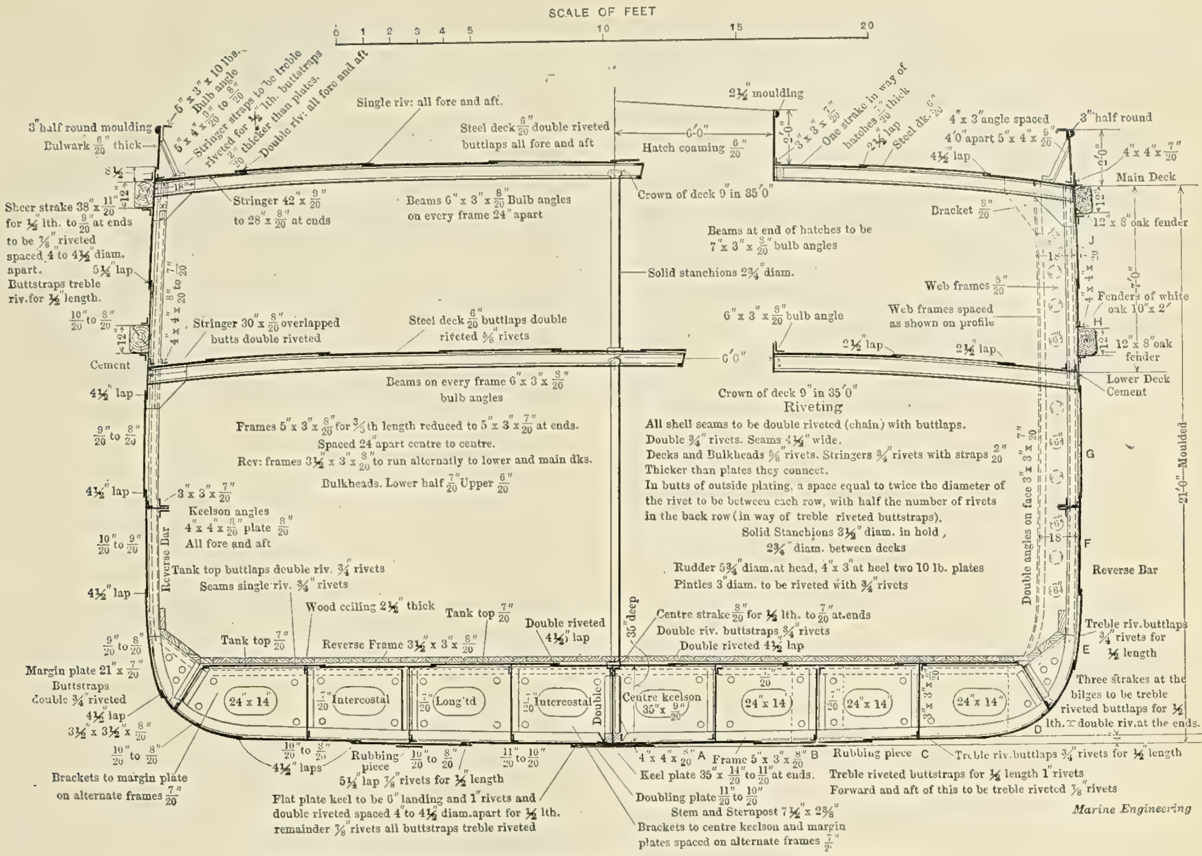
Length overall	215 ft. 0 in.
" bet. perps	207 " 0 "
Breadth, moulded	35 " 0 "
Depth, moulded	21 " 0 "
Draft, loaded	17 " 0 "

As will be seen in the accompanying plans the barges have steel hulls, two steel decks and steel house aft, and a double bottom for water ballast. As they are identical the description of one will answer for all.

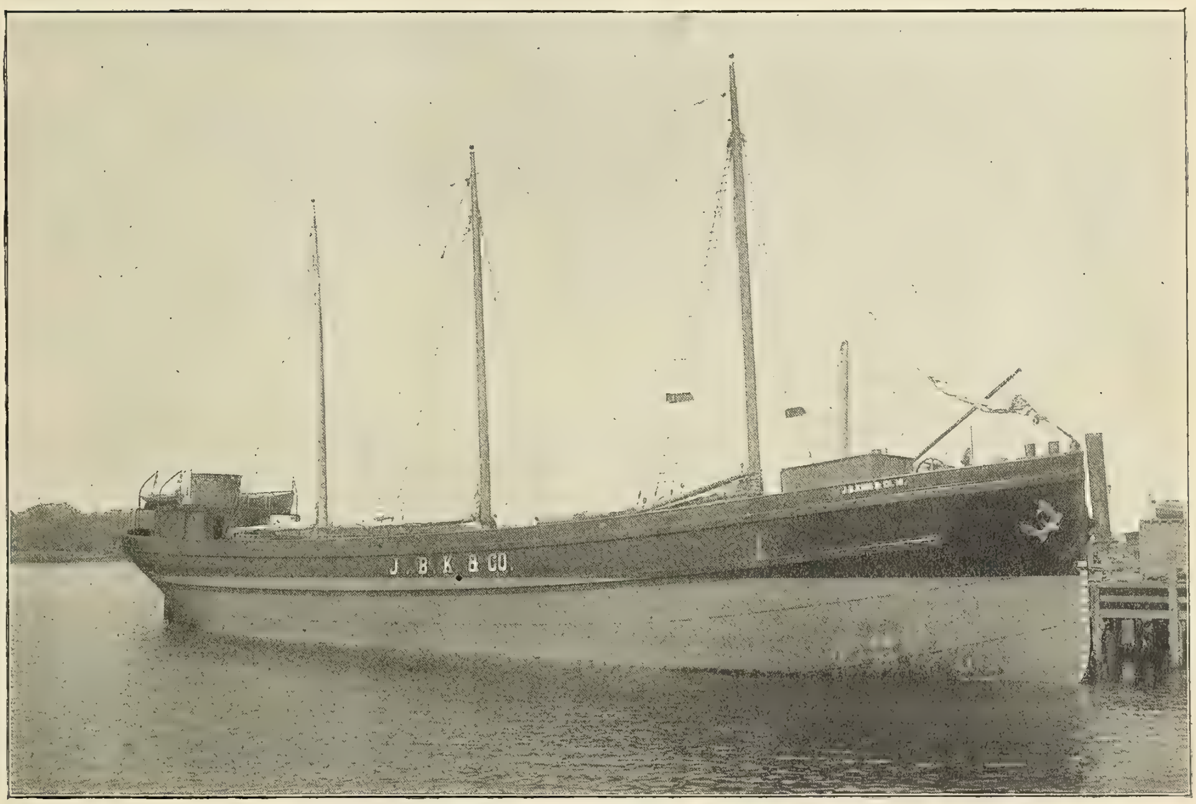
Mild steel of between 50,000 lb. and 60,000 lb. tensile strength was specified for the hull. The flat plate keel is 35 in. wide with doubling plate on the inside, the two well riveted together. The frames are angle bars 5 in. by 3 in. spaced 24 in. centers in one piece from the tank side to the main deck. Reverse frames are 3 1-2 in. by 3 angles following the tops of the floor plates and cut at the tank side, every alternate frame extending to the main deck and intermediate frames to 6 in. above the lower deck stringer plate. The floor plates are fitted in the double bottom on every alternate frame, 35 in. deep, and stiffened at the upper edges by the reverse frames, the intermediate frames being connected to the center keelson and tank margin plate with large bracket plates. All floor plates are lightened with manholes.

PLANS OF STEEL TOW BARGES FOR DEEP SEA TRADE—BUILT BY THE BURLEE DRY DOCK CO., PORT RICHMOND, STATEN ISLAND, N. Y.





MID SECTION OF 2,000 TON STEEL TOW BARGES FOR ATLANTIC COAST TRADE.



PHOTOGRAPH OF 2,000 TON STEEL SEA GOING TOW BARGE FOR J. B. KING CO.

The center keelson runs the whole length of the double bottom. It is 35 in. wide and is connected to the double bottom and keel plate by 4 in. by 4 in. double angles. On each side of the center keelson three plate girders run the whole length of the tank.

There are twelve belt frames, one in the middle of each hatch. Two watertight bulkheads are fitted, all pipes and connections through these bulkheads being made watertight.

Main deck beams, 6 in. by 3 in. bulb angles, are on every frame except at the watertight bulkheads and the ends of hatches. Lower deck beams of 6 in. by 3 in. bulb angle are secured to all frames fore and aft by gussets. The main deck is steel with all double laps double riveted. In the hold there is a fore and aft row of iron stanchions along the center line, spaced 4 ft. apart, riveted at heads and heels to the beams and tank top. The 'tween deck stanchions are similarly spaced and there are extra stanchions under the towing bitts, windlass, etc. There are five hatches with main deck coamings 2 ft. high and lower deck coamings 6 in. high.

Towing bitts are fitted at the forward and after ends, secured to the deck, and supported underneath by heavy iron stanchions. There are five pairs of cast iron double bitts on each side.

The deck house is 20 ft. long and about 16 ft. wide in the widest part. In the pilot house overhead there is accommodation for the skipper.

Spars and sails are fitted for a three masted fore and aft schooner. The standing rigging is of galvanized wire set up with turnbuckles.

On the 'tween deck forward of the forward bulkhead the machinery is installed. This includes a vertical donkey boiler 4 ft. dia. and 8 ft. high, fitted with injector and small feed pump. A bilge and tank pump of the duplex pattern 7 1-2 in. by 8 1-2 in. by 10 in. is fitted. This is piped so as to pump separately from each tank and well, and there is also a sea connection. The discharge is overboard or through three hose connections as desired.

On deck in a house forward a double drum hoister with double cylinders 7 in. dia. and 10 in. stroke, designed to raise 4,000 lb., single whip is installed.

A messenger chain connects the hoisting engine with the windlass forward, and this is also fitted to be operated by hand. The chain pipes lead to lockers in the lower hold.

Two Baldt steel anchors of 3,600 lb. and 2,200 lb. respectively are carried.

A hand steering gear with 6 ft. wheel is fitted in the pilot house and on deck there is a hand pump with 4 in. suction.

There are two water tanks fitted, each with a capacity of about 2,000 gal.

Two boats are carried, one 22 ft. and one 16 ft., in accordance with the U. S. regulations.

Since they were finished these barges have seen considerable service, towing at sea under favorable conditions, when loaded, at the rate of about 9 knots.

A consolidation of the formerly separate interests of the famous Union and Castle steamship lines has been effected, and all the vessels will now fly one flag. These lines maintain regular communication between English and South African ports.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—II.

BY CECIL H. PEABODY.

The planimeter shown by Fig. 3 has an adjustable tracing-arm; it can be set to mark lettered 10□" with the arm 4 in. long, and will then be used just as Figs. 1 and 2 are used. The measuring-wheel is set beyond the hinge, and will consequently roll backward as the tracing-arm swings forward, but the effect of the swinging of that arm forward and backward to the original position at the starting point after tracing a diagram will finally have no effect on the area re-

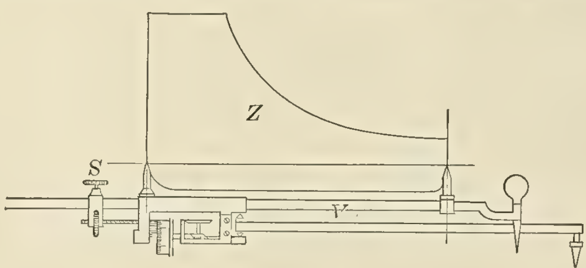


FIG. 11.

corded by the instrument, provided that it is used as described. If the tracing-arm is long enough, it may be set to give 8 in. from the hinge to the tracing-point, in which case one revolution of the wheel will correspond to 8 × 2 1-2 = 20 sq. in.; the readings in turns and decimals of a turn of the wheel are now to be multiplied by 20 to get the area in square inches.

One square foot is equal to 144 sq. in., or $\frac{1}{10}$th of a square foot is 14.4 sq. in. In order to have one turn of the wheel record 14.4 sq. in., it is sufficient to make the tracing-arm

$$14.4 \div 2.5 = 5.76$$

inches long. A mark on the tracing-arm lettered $\frac{1}{10}$□' enables us to set the instrument at that length so that it may be used to measure areas in tenths of a square foot.

Again, one decimeter is equal to 3.979 in., and one square centimeter is equal to

$$\overline{3.979}^2 = 15.5$$

sq. in.; therefore, to have the planimeter record square decimeters it is sufficient to make the tracing-arm

$$15.5 \div 2.5 = 6.2$$

inches long. A mark lettered 1□dec. allows us to set the arm for this purpose.

Finally, the arm is provided with two points on the back, by aid of which the length of the tracing-arm can be made equal to the length of the indicator diagram, as shown by Fig. 11. If the instrument is set in this manner and an indicator diagram is traced, the reading of the wheel will give the mean height of the diagram in 40ths of an inch, each subdivision of the wheel being read as $\frac{1}{40}$ of an inch. If the scale for the diagram is 40, then the reading of the planimeter gives the mean effective pressure directly. The mean effective pressure for other scales ordinarily used for indicator diagrams can be easily obtained; for example, with a 60 scale it is sufficient to multiply by 1.5 or to

add one-half to the reading of the planimeter. To understand this use of the instrument, it must be remembered that the mean height of an indicator diagram, that is, the height of a rectangle having the same area, is obtained by dividing the area in square inches by the length of the diagram. Now, the area corresponding to one revolution of the wheel of a planimeter is equal to the circumference of the wheel multiplied by the length of the arm. Consequently when the arm is made equal to the length of the diagram, omitting to multiply by the length of the arm is equivalent to dividing the area by the length of the diagram; the reading of the wheel gives the resultant distance over which it has rolled. Since the circumference of the wheel is 2 1-2., in $\frac{1}{100}$ of the circumference is $\frac{2.5}{100}=\frac{1}{40}$ of an inch.

Thus far it has been assumed that the pivot of the guiding-arm is outside the diagram to be measured. In dealing with large areas it may be convenient to place the pivot near the middle of the diagram, and to trace its perimeter with a continuous forward motion of the tracing-arm around to the starting-point. To find the area of the diagram add a constant given by the makers and engraved on the instrument to the difference of the initial and final readings.

The way in which the planimeter measures such a figure may be investigated by aid of a diagram like Fig. 12, which is drawn by first moving the tracing-arm parallel to itself, as from *hp* to *iq*, and then pivoting it about the hinge, as from *ig* to *ir*, and so on alternately entirely round to the starting-point. The area of the figure is made up of three parts: (1) The sum of the areas of the parallel-sided figures, like *hpqi*, which are properly measured and recorded by the planimeter; (2) the sum of the sectors, like *qir*, which

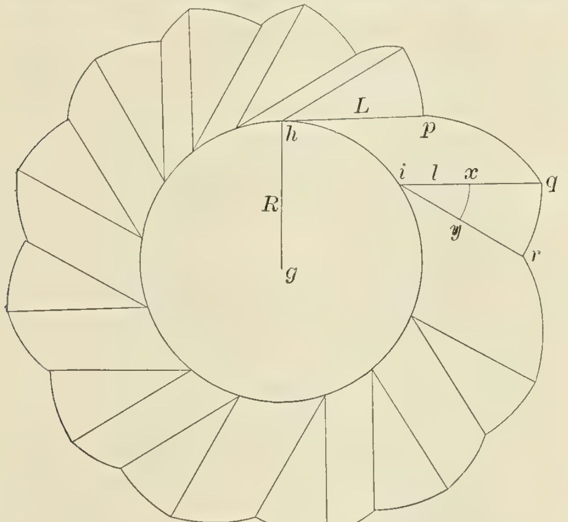


FIG. 12.

sum is equal to πL^2, the area of circle having the length of the tracing-arm for a radius, and (3) the area πR^2 of the circle described by the guiding-arm *gh*. While the tracing-arm is swinging from *ig* to *ir* the wheel rolls over the arc *xy*; the sum of the several arcs, like *xy*, is the circumference $2\pi l$ of a circle, having for its radius the distance of the wheel from the hinge; the planimeter adds to the proper record of the areas of the parallel-sided figures an amount, $2\pi lL$, which must be subtracted to get the true area of the figure. The figure consequently has for its area the record of the planimeter plus the constant.

$$\pi L^2 + \pi R^2 - 2\pi lL.$$

This constant depends on the lengths of the arms and the position of the wheel; a planimeter with an arm of fixed length, like Fig. 1, will have one value for this constant, which may be found engraved on the weight which holds down the pivot; the planimeter shown by Fig. 3 will have a constant for each setting of the arm engraved near the mark for setting the arm.

The wheel of the planimeter shown by Fig. 3 being beyond the hinge will roll *backward* while the arm is

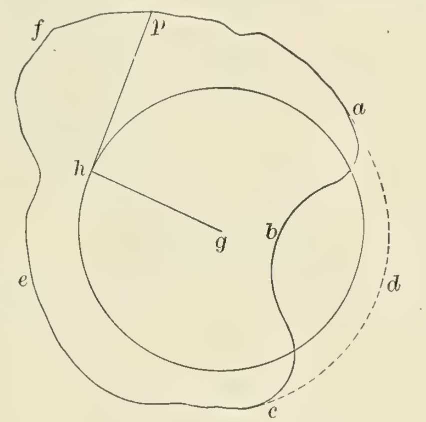


FIG. 13.

swung through an angle; consequently the term $2\pi lL$ will have the position sign in the above equation.

In Fig. 12 twelve sectors of 30° each were chosen so that it shall be more immediately evident that this sum is a circle having the tracing-arm for a radius. But it is evident that the sum of such sectors, whatever their angle, must be a circle, since the arm makes one complete revolution in passing round from *hp* to *hp* again, while the outline of the figure is traced. An approximation to any figure having a form like Fig. 12 can be obtained by taking a sufficient number of figures like *hpqi* and sectors like *qir;* or if the true outline is traced the planimeter will give the basis for determining the area, allowing for the constant. Moreover, the planimeter can be used to measure a diagram like Fig. 13, which lies partly outside and partly inside the circle described by the guiding-arm *gh*. For it is clear that we can apply this method for measuring the figure *adcef*, and that we may (after returning the tracing-point to *a*) subtract the area *abcd* by tracing it in that order, *i. e.*, toward the left; but since the dotted line *adc* will in that case be traced twice, once forward and once backward, we will get the same result by omitting it, that is, by tracing the outline *abcef* in the first instance.

According to a recent cable dispatch from Constantinople, the Turkish torpedo boat *Schamyl* blew up in the harbor of Beyrout, Syria, and 21 of the crew were killed. No boat of this name appears in the list of Turkish naval vessels. There is, however, the *Seham*, 127 ft. long with a speed of 22 knots. This boat was built about eight years ago.

AN ACCOUNT OF A RECORD-BREAKING TRIP ACROSS THE PACIFIC OCEAN.

BY WM. H. CRAWFORD, JR.

To many the suggestion of a record breaking trip across the Pacific would be a novelty, for it is to the Atlantic trade, chiefly, that persons interested in marine affairs are accustomed to look for record smashing passages. Competition on the Atlantic has called forth the utmost skill of the shipbuilder and strained the resources of the ship-owner; whereas, on the Pacific things have moved along in such a quiet way that comparatively few persons on learning the duration of a trip across that ocean would know whether it meant fast or slow speed.

Recent happenings of national importance, however, have created a lively interest in matters relating to the Pacific ocean, and therefore it seems timely to recall a successful attempt to lower the Transpacific record. This, indeed, was before the days of active competition, and it was a race against time and valued reputation rather than against the necessity of lowering the record of a rival company.

As is generally known there are two important routes from the Pacific coast of North America to the Orient; one from San Francisco via the Sandwich Islands to Yokohama, and thence south to Hong Kong, and the other from Vancouver or Puget Sound, following the great circle track north, skirting the Aleutian Islands, the coast of Japan to Yokohama, and then south, as the former route. The distance from San Francisco to Yokohama via Honolulu is 5,428 miles, and it takes from 16 to 18 days to run over, while the northern route is 4,270 miles long, and steamers usually cross in from 13 to 14 days.

The Canadian Pacific S. S. Co. operates three first class steamships regularly between Hong Kong and Vancouver. These vessels* are named the *Empress of Japan*, the *Empress of India*, and the *Empress of China*. They are very handsome vessels, with clipper bows, two smoke stacks and three pole masts. They were built at Barrow, on the East coast of England, in 1891, and are of these dimensions: Length, 485 ft.; beam, 51 ft.; depth, 36 ft.; displacement, 8,500 tons, and 10,000 I. H. P. The company receives a large sum from the British Government for the carriage of mails, and there is a penalty of $2,500 for every 24 hours over the contract time, when the mails are late.

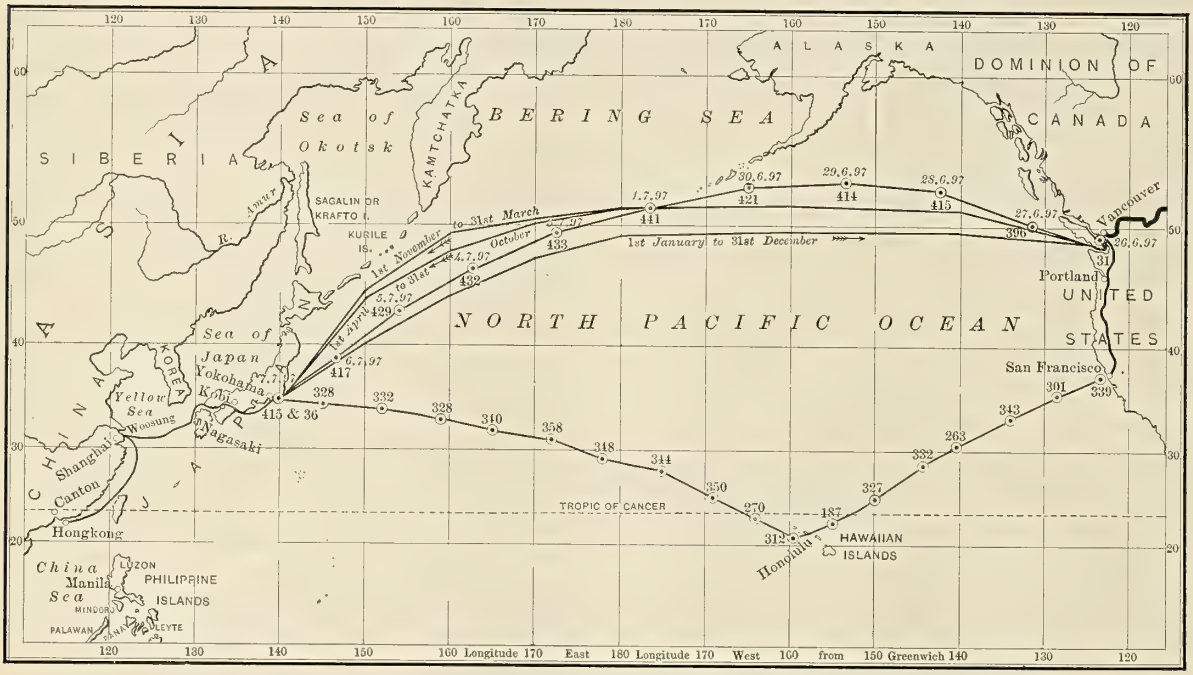


CHART OF NORTH PACIFIC OCEAN SHOWING STEAMSHIP ROUTES AND COMPARATIVE DAILY RUNS.

The regularity with which these steamers cover the 4,000 odd miles across, both winter and summer, is such that the service has come to be known as the "Ferry Line." It was my good fortune in June, 1897, to be a passenger from Montreal to Vancouver over the C. P. Ry. and on the S. S. *Empress of Japan* from Vancouver to Yokohama In crossing the Selkirk Mountains on the C. P. Ry., we met with great delay by reason of unprecedented floods, which carried away an important bridge, so that on reaching the western terminus of the line we were no less than 6 days and 19 hours late. This train was the regular steamer connection with the through mails, due to arrive 24 hours before sailing time, so the *Empress of Japan* was forced to await its coming.

No time was lost in transferring passengers, mails and baggage from train to steamer, and within two hours after our arrival at Vancouver we were steaming down Puget Sound on what turned out to be the fastest run ever made across the Pacific Ocean. Special preparations had been made for it. The coal supply was nearly doubled, so much being crowded on board that piles of it remained in sight on deck for several

* For a photograph of these ships see March issue, page 98.—Ed. Marine Engineering.

days. Reference to the accompanying chart will give a good idea of the daily runs, as compared with an average voyage via the Sandwich Islands.

Good weather favored us from the very start. The only drawback was a dense fog; but a ship has the ocean pretty much to itself up in this part of the world, so very little fear is occasioned by thick weather. It is a fact that up to about a year or so ago there were less than thirty steamers engaged in the regular service between the Pacific Coast and the Orient.

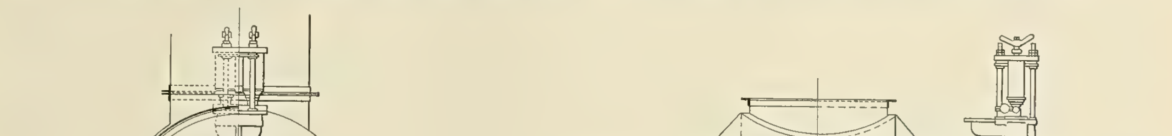
On this particular voyage not a stick was sighted from start to finish, and the engines kept up their continual grind day after day without even a slow down, until July 7, when the coast of Japan was sighted. The same day, by 1 o'clock in the afternoon, we crossed the line at Kannonsaki Light, and steamed into Yokohama harbor with a record of 10 days and 3 hours to our credit, and the remarkable average speed for the 10 days of 17.14 knots. No excessive vibration was noticed during the entire trip, and the performance was all the more creditable when it is considered that the engines were ready to start right off again and run for 7 days more, to reach Hong Kong. The time spent in Yokohama was just enough to allow for taking on a fresh supply of coal before the *Empress* started again. Stops were made at Nagasaki and Shanghai, and finally, after 17 1-2 days of almost continual steaming, the anchor was dropped in Hong Kong harbor with still a margin of an hour or so to save the late mail fine, and with a record of speed across the Pacific Ocean that far surpassed anything hitherto accomplished, and which stands unbeaten to-day.

A decision to purchase the Holland submarine torpedo boat has been reached by the U. S. Government.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—V.

Yarrow Water Tube Boiler.

The Yarrow water tube boiler is the invention of A. F. Yarrow, the English torpedo boat builder, who has installed it in the large number of torpedo boats and destroyers he has turned out for various navies. It is of the small straight tube type, with a large central steam and water drum at the top and water chambers below, at the level of and extending along each side of the grate. The top drum and the bottom chambers are connected by a row of straight tubes at each side, the tubes being inclined inwards at an angle depending on the width of the grate. In the earlier boilers of this type the top drum was made in halves connected by a bolted joint. This was abandoned, however, in favor of the drum riveted up with butt joints and double butt straps. The lower tube plates were formerly made flat, but are now slightly curved and are lap riveted to the lower pockets. In both the drum and the lower tube plates the metal is of increased thickness where the tubes are expanded in. By reference to the accompanying engravings it will be noticed that there is a large manhole in the back end of the upper drum, with cover bolted on. This permits of free ingress to the interior of the drum, and without the necessity for breaking the joints of any connections. In the center of the manhole plate there is a small hand hole and a similar hole is located in the front end of the drum for purposes of ordinary inspection. The ends of the water chambers, front and back, are flanged and closed by curved heads bolted in place. Small sludge doors are fitted in these bottom heads. By



DRAWINGS OF YARROW WATER TUBE BOILER.

opening up the top drum and the bottom chambers, the inside of every tube in the boiler can be inspected throughout its entire length, by the aid of a portable lamp, and any necessary cleaning can be readily accomplished. In the earlier boilers copper tubes were used, but they are now invariably of solid drawn steel, galvanized inside and out. The tubes are set in straight rows front to back, each alternate row being staggered, so that the gases are broken up and made to pass around the entire surface of the tubes on their way to the stack. By a suitable arrangement of baffles the path of the gases is controlled. This boiler is not fitted with any independent downcomers, the circulation being maintained in the generating tubes, the upper ends of which are, of course, submerged. In no part of the boiler is the metal exposed to the direct action of the gases on the one side and steam only on the other. In the casing which completely encloses the boiler, and which is lined with fireproof material, doors are placed in the ends and sides so that the exteriors of the tubes farthest from the grate can be got at readily. In small boilers of this type only one fire door is needed, but in those of large size, with wide grates, two or three doors are provided for working the fires. This boiler is built to withstand the most severe use. Not only has it been fitted in torpedo craft, but in large war vessels, steam yachts, and other craft. It is built in England by Yarrow & Co., Poplar, London, and the exclusive rights in this boiler for the United States are held by The Willam Cramp & Sons Ship and Engine Building Co., Beach and Ball streets, Philadelphia, Pa.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—II.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

ARMOR.

In no respect has there been a more marked crystallization of naval opinion abroad, of late, than that which has taken place on the question of the best distribution of the weight assigned to armor in a ship's design. All officers are now in accord that protection must be widely diffused, and that it cannot be restricted to the water-line and gun positions. The trend of professional opinion in the British navy has been in this direction for some time past, as is evidenced by the latest battleships and armored cruisers. Elsewhere there have been designs of date not much prior to the war with Spain which showed a very wide expanse of side without protection, while heavy armor guarded a few parts. A few years ago France produced, in the *Dupuy de Lôme*, an armored cruiser lacking in size, but having admirable general protection, but there has not been adherence to this feature. Some of the later foreign armored cruisers have no protection between the water-line belt and the gun positions on the main deck, but current discussion shows that in battleships and armored cruisers laid down hereafter this will not be repeated. The appalling disablement of crew, which, under well-directed gun fire, may occur on board armored ships lacking widely distributed protection is now fully appreciated. The need of extending the armored water-line belt to the extremities is also urged, and the protection of the personnel in the conning tower is regarded as essential.

The recent war confirmed and impressed the lesson of that between China and Japan as to the absolute necessity of protection of the personnel. Proving ground tests have shown for the latest new process face-hardened armor such a remarkable resistance to penetration that there can be much reduction of thickness, thus enabling the need for covering a more extended area to be met, although at increased cost. There has been a prompt acceptance of the new conditions.

In foreign armor contracts quality is made the feature of paramount importance, cost being a secondary consideration. The best type of armor procurable at the time is purchased. So general is this that it holds good, not only in the more important foreign navies, but even in some whose expenditures are necessarily much restricted. The fact is fully realized that if a ship whose armor is contracted for to-day is hereafter to be tested in battle against an opponent having protection of a superior quality, permitting better distribution, this one point may have a decisive influence on the result.

SPECIAL FEATURES OF CONSTRUCTION AND EQUIPMENT.

The destructon of the Spanish ships by fire caused by American shells has led to universal effort to abolish wood and combustible materials from naval vessels. This effort is marked by such vigor that its results may practically be regarded as accomplished. In some of the latest ships the furniture is of metal or of fireproofed wood, the steel bulkheads have ornamental asbestos covering, and the steel decks are given a plastic non-flammable coating. Decks partly of wood are being replaced by steel. In clearing ship for action nothing combustible is permitted above the protective deck. Canvas boats permitting disassemblage and stowage below will be tested for some purposes.

The action of the French budget committee, in declining to make provision for the repair and maintenance of certain old wooden ships, recognizes the lack of military value of such vessels. A step in the same direction is the replacing of old wooden French ships for colonial service by others of more modern type. In these measures France is but following the policy already adopted in other navies.

Provision for extinguishing fire has been much extended and greatly increased. Fire mains are now carried under the protective deck, with numerous vertical leads from them.

The general adoption of water-tube boilers by progressive foreign navies has passed beyond the stage of discussion and may be regarded as an accomplished fact. The only point now remaining open in this respect is the question of the best type.

Search-lights, rapid-fire guns of the secondary batteries, flotillas of picket boats when at anchor, and numerous flanking torpedo boat destroyers and cruisers when under way, form the chief defense of battleships against torpedoes. Recent improvements and attachments give torpedoes much greater range and accuracy than they have had heretofore and increase the need of defense against them. Thus the best position for search-lights is one of great importance and has been much

*From Notes on Naval Progress issued by U. S. Office of Naval Intelligence, Washington, D. C.

investigated abroad. The present practice is to mount some search-lights aloft and others as low as they can be used in a sea way. The low ones, having their beams parallel to the water, are best for picking up an object on the surface, but their beams blind the gun pointers of the secondary battery. The lights, which are placed high, serve to illuminate the object after it is picked up. It is evident that co-operation between the search-lights and the battery is necessary.

Though some foreign battleships still have torpedo nets, they are no longer regarded with favor abroad.

Military masts are considered important for battleships. The tendency is to shorten them, and their development is in the direction of armored towers with circular stairways, enabling men to go aloft to the fighting tops and to have ammunition supplied to them therein under protection. There is communication from the tops to the conning towers to facilitate reporting ranges and signals. For cruisers the present tendency seems to be to use pole masts.

The arguments against an extensive use of longitudinal bulkheads below the protective deck, which followed the capsizing of the *Victoria* after her collision with the *Camperdown,* have been counteracted this year by the fact that the German armored coast defense ship *Aegir* was saved from sinking as a result of collision during fleet maneuvers by flooding compartments on the side opposite the injury, thus heeling the ship sufficiently to bring the leak above the water line. It is now held that valves to permit the passage of water across to opposite compartments will obviate the danger of capsizing.

Cellulose protection is still used. In some cases cork is preferred, in spite of its greater weight. Some authorities hold that to avoid any danger of corrosive action it is well to keep the coffer-dams empty, clean and dry, ready to be packed with cellulose in case of war.

Atlantic Liners.—Several of the large transatlantic steamships which have been engaged in transporting troops to South Africa have been released by the British Government. The Anchor liner *City of Rome* has resumed her New York sailings from Glasgow. The White Star liner *Majestic* will also be back in her old trade shortly, and the Cunarder *Umbria* is soon to follow.

In a special report of the Association of Engineering Societies by Secretary John C. Trautwine, Jr., attention is called to the very prosperous conditions of this organization. Its individual membership is now 1,475, made up of professional men who are members of various local scientific societies in the East, South, Middle West and Pacific slope. There has been an accompanying steady increase in the assets, so much so indeed that a rebate on assessments was granted for the purpose of reducing the surplus—this amounted to $2,443 at the end of 1899. In the proceedings of the Association, publication of many important technical and scientific papers is made at a comparatively small cost to each organization, the expenses of the journal being distributed over the entire membership. In this way many of the smaller societies are enabled to have a permanent record of their transactions, which, on account of the cost, they could not accomplish unaided.

LAUNCHES—HOME AND FOREIGN.

S. S. Kvichak.—At the yard of Wolf & Zwicker, Portland, Ore., the new steel vessel *Kvichak,* for the Alaska Packers' Association, was launched April 14. Her tonnage is 1,063 tons gross.

Tug Tormentor.—An ocean-going tug, the *Tormentor,* was launched at the yard of the Atlantic Works in East Boston, Mass., March 31. The boat is to the order of the Red Star Towing & Wrecking Co.

Sch. Calumet.—A four masted wooden schooner, the *Calumet,* was launched by Kelly, Spear & Co., Bath, Me., on April 14. The vessel is: Length, 180 ft.; beam, 40 ft.; depth, 18 ft. John S. Emery & Co., Boston, Mass., are the owners.

Tug Zetus.—At the McKie shipyard, East Boston, Mass., the harbor tug, *Zetus,* was launched March 31. She was built for the local service of the Boston Tow Boat Co., and was christened by Miss Alice Flynn, daughter of the superintendent of the company.

Barge Black Diamond.—The three masted wooden tow barge *Black Diamond,* for the Bee Line Transportation Co., was launched at the New England Co.'s yard, Bath, Me., April 9. The barge is of these dimensions: Length, 188 ft.; beam, 34 ft.; depth, 18 ft.; carrying capacity, 1,800 tons.

Sch. Malcolm Baxter, Jr.—The 4-masted, 1,700 ton schooner, *Malcolm Baxter, Jr.,* was launched at the yard of H. M. Bean, Camden, Me., March 29. Her dimensions are: Length, 216 ft. on keel, 226.2 ft. over all; beam, 45 ft.; depth, 20.8 ft. Her lower masts are 110 ft. long and topmasts 53 ft. long. White oak and southern pine were the materials used in her construction.

T. S. S. Lake Champlain.—A new steamer of about 8,000 tons dead-weight capacity for the Canadian-British trade of Elder Dempster & Co. was launched recently on the Mersey. The dimensions of this vessel are: Length, 465 ft.; beam, 53 ft.; depth, 38 ft. 7 in. to shelter deck; gross tonnage 7,500 tons. She is built to rate 100 A1 at Lloyds. Accommodation will be provided for about 100 saloon, 80 second cabin and 500 steerage passengers.

F. B. General Sumner.—A new ferryboat for the city of Boston, the *General Sumner,* was launched from the McKee yard, East Boston, April 7. She is built of wood and is fitted with compound screw engines. Her dimensions are: Length, 164 ft. 3 in.; beam, 57 ft.; depth of hold, 14 ft. The cabins are to be finished in white pine and burlap, with papier mâchè carvings. The seats will be of mahogany, and the floors will be laid in quartered oak.

S. S. Hyades.—At the Maryland Steel Co.'s shipyard at Sparrow's Point, Md., the S. S. *Hyades,* for the Boston Tow Boat Co., was launched March 27. This vessel is a sister ship to the S. S. *Pleiades* recently completed at the yard and put into service. The vessels are of the money earning tramp type, built especially for carrying coal or bulk cargo. The dimensions of the vessel are: Length over all, 350 ft.; beam, moulded, 47 ft.; depth at side moulded, 28 ft.; gross tonnage about 4,000 tons.

S. S. Excelsior.—For the first time in a number of years the inhabitants of New Haven witnessed the launch of a new vessel, March 31. On that day the wooden steamer *Excelsior* for the Brooklyn Grain Elevator Co. was put into the water at the yard of J. E. Marr in West Haven. The dimensions of the vessel are: Length, 154 ft. 8 in.; beam, 33 ft. 10 in.; depth of hold, 16 ft. Her machinery is to be installed at New York where the hull was towed.

S. S. Manna-Hata.—At Harlan & Hollingsworth's yard, Wilmington, Del., the S. S. *Manna-Hata*, was launched March 31. She is a sister ship to the *Chesapeake* launched earlier in the month, and reported in our last issue. In dimensions the new vessel measures: Length over all, 219 ft., between perpendiculars, 205 ft.; beam, 32 ft.; depth to upper deck at center, 23 ft. 3 in. She is built of steel throughout. She will be put on the Shriver Line running "outside" from New York to Baltimore.

S. S. William Cassel Rhodes.—At the Lorain yard of the American Shipbuilding Co. the steamer *W. C. Rhodes* was launched April 7. She was built to the order of the Lower Lakes Steamship Co., for trade through the Welland Canal and the St. Lawrence River canals, and is of these dimensions: Length, 252 ft.; beam, 42 ft.; depth, 26 ft. 6 in. The ceremony of christening the new vessel was performed by Miss Stella Hatch. The vessel will be used chiefly for carrying package freight.

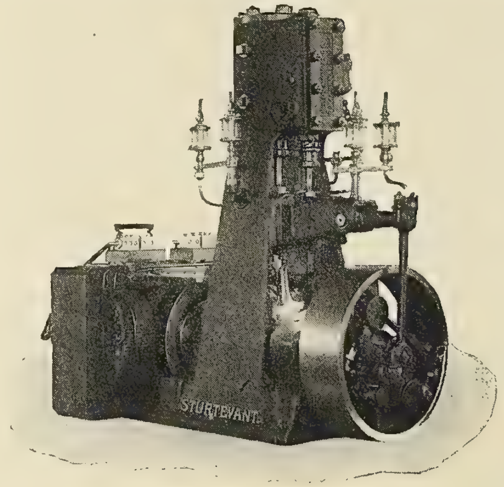
S. Y. Elfrida.—At the yard of the Gas Engine & Power Co., and Charles L. Seabury & Co., Con., Morris Heights, N. Y., the steam yacht *Elfrida* for Dr. Seward Webb was launched April 10. The yacht which is intended for use on Lake Champlain is built to pass through the canals to reach her destination. The overhanging ends will be carried on deck until the lake is reached, when they will be shipped. The dimensions of the new yacht are: Length over all, 141 ft., water line, 113 ft.; beam, 18 ft.; draft, 7 ft. 6 in. She will have twin screws driven by triple expansion engines. Two pole masts will be fitted. She will have a maximum speed of 16 miles an hour.

T. S. S. Morro Castle.—One of the largest and finest freight and passenger vessels ever built in this country was put into the water at Cramp's yard in Philadelphia, April 14. The new vessel, the *Morro Castle*, was originally laid down for the Plant Line, but later was sold to the Cuba Mail Steamship Co., more familiarly known as the Ward Line. In dimensions this fine ship measures: Length, 400 ft.; beam, 50 ft.; depth, 36 ft. 6 in.; displacement, 6,900 tons. She will be fitted with triple expansion engines of 8,000 I. H. P., driving twin screws, and is expected to attain a speed of 18 knots on trial. Her boilers are of the single ended Scotch type built for a working pressure of 170 lbs. Elaborate accommodation for about 250 passengers of all classes will be provided. The launching of the vessel was made the occasion of demonstrations of good will on the part of the employees toward the executive officers of the company, presentations of floral gifts being made by deputations representing workmen in the yard to both Charles H. Cramp and Edwin S. Cramp. The christening ceremony was performed by Miss Florence Cramp.

IMPROVED APPARATUS.

Small Lighting Set.

We illustrate in the accompanying engraving a very small generating set, designed primarily for lighting purposes, and built by the B. F. Sturtevant Co., of Boston, Mass. The engine has a cylinder 3 in. dia., and a stroke of 2 1-2 in. It is self-contained, as is clearly indicated, and the speed is regulated by a shaft governor. The valve is of the piston type; all bearings are adjustable, and are provided with direct oiling devices. A speed of 800 rev. per min. is attainable, and may be constantly maintained with accurate regulation. The generator is of the 2 1-2 K. W. size, designed to develop its rated output without sparking, and with a minimum temperature rise. The entire weight of the set is a little over 600 lb., the engine constituting a little over 40 per cent of this weight. The field frame is attached directly to the engine frame, and placed at the floor level so as to be as stable as possible. This arrangement was facilitated by the adoption of the consequent pole type, giving a four-pole field with only two field coils. As



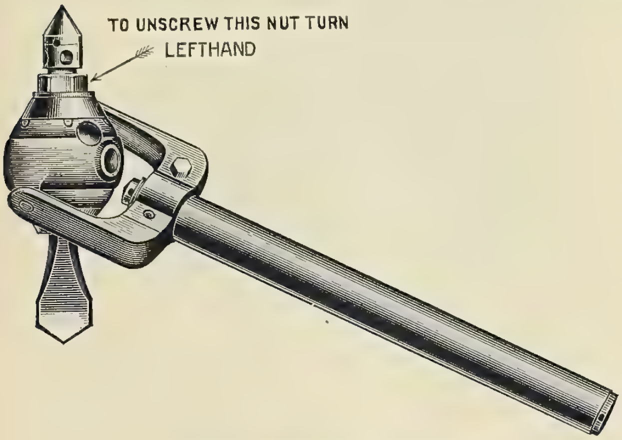
STURTEVANT LIGHTING SET.

these coils are placed on the horizontal pole pieces, the height of the shaft center is reduced to a minimum. The total floor area occupied by this set is only 21 in. by 35 in., and the total height is 30 in. This type of lighting set is built in sizes for 25, 37 and and 50-16 C. P. lights.

Williams Universal Ratchet.

An improved form of ratchet drill is shown in the engraving of the Williams universal ratchet. This tool differs in operation from the ordinary ratchet in that, instead of a to and fro motion, the handle can be worked in any direction. There are no bevel gears and no ball joints, and all bearings are cylindrical. The pawls do not slide lengthwise on the ratchet teeth. The universal quality of the tool is due to the fact that the axes of the two trunnions on which the handle turns form an acute angle with the axis of the drill. About two inches of motion at the end of the handle in any direction will drive the drill, and by the use of a collet holes up to 2 in. dia. can be worked. Inside the case there is a ratchet 1 3-4 in. dia., with 12 teeth and five

pawls, one of which is always engaged. Thus the pawls catch sixty times in a revolution, and much faster work can be accomplished than with the old style drill. The tool is made of forged steel and the springs

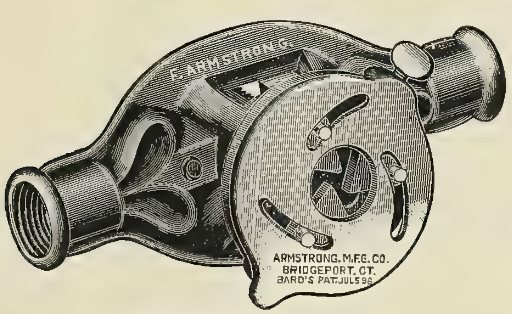


WILLIAMS UNIVERSAL RATCHET.

which actuate the pawls are made of finely tempered piano wire. The tool complete weighs 11 lb. It is in extensive use by steamship companies, railroads and machine and boiler shops. It is made by the Waterbury Tool Co., Waterbury, Conn.

Bard Adjustable Bushing.

The accompanying illustration shows the Bard adjustable bushing, a new appliance for use with die-stocks of all sizes. The bushing is fitted with three hardened jaws, which are moved to and from the center by means of a cam plate, and by fastening the plate with a thumb screw the jaws are firmly held in any desired position. The bushing is made to fit any die-stock in place of the common ring bushing, and adjusts to all sizes of pipes or bolts. The adjustable jaws always make a perfect center for the pipe and, fitting closely around the pipe, insure cutting a straight thread. When once attached to the die-stock it may

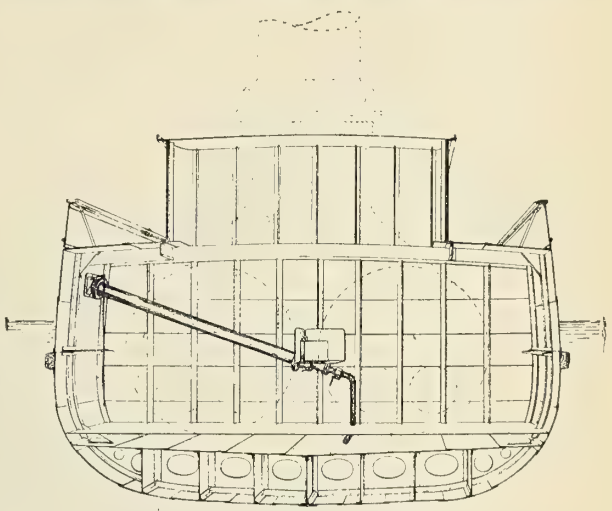


BARD ADJUSTABLE BUSHING.

always remain there, being adjustable to any size of pipe or bolts that the stock will thread. It thus does away with the necessity of carrying a number of loose ring bushings with each stock. In threading short nipples with this bushing, it is never necessary to file down the coupling of the nipple holder. Bushing No. 3 is made for use either with or without a leader screw, according to the stock in which they are to be used. For old die-stocks where a leader screw or follower is necessary No. 3 bushings are made (taking up to 2 in.) combined with a leading screw, all in one tool. This is a useful addition to an old style 2 in. die-stock, using solid dies. The Bard bushing is manufactured by the Armstrong Manufacturing Co., Bridgeport, Conn.

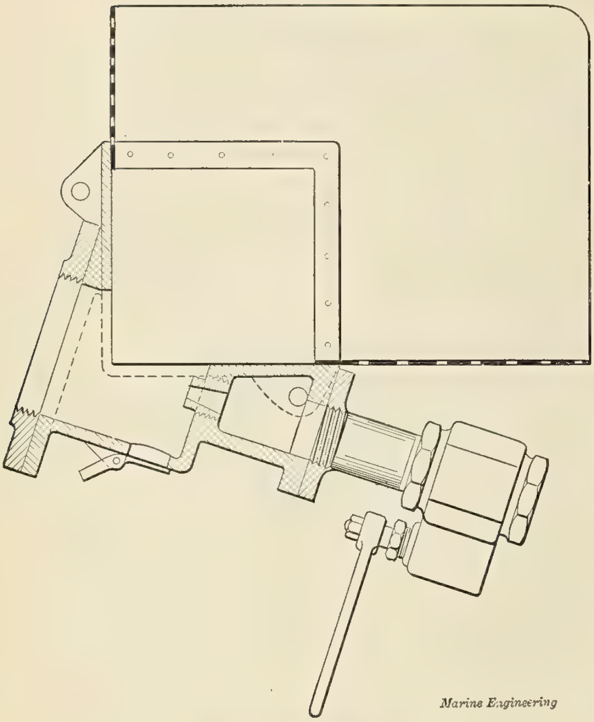
Detroit Ash Gun.

One of the most troublesome operations in connection with the engineer's department of a steamship is the getting rid of ashes. To lessen the labor attendant on this operation, and to enable it to be carried out expeditiously, the Detroit Shipbuilding Co. has designed an ash gun, by means of which the ashes are disposed of direct from the fire room floor without the necessity of any labor above decks. In the cross section of a vessel here printed, the gun is shown in position, with the discharge pipe leading up to the outlet on the ship's side above the water line. The form of gun illustrated in the detail drawing is extensively used on the Great Lakes and also in smooth-water vessels. What might be termed the



MID SECTION SHOWING ASH GUN IN POSITION.

"breech mechanism" of this gun consists of a cast-iron shelf or receiver (with an opening to the bore of the gun), placed at a convenient height from the floor in the boiler room, on to which the ashes are shoveled. Connection is made at the rear end of the gun with one of the ship's pumps supplying a jet of water under pressure. A throttle is placed under the shelf to control this jet, and when this is opened, and the gun loaded, the ashes are carried up the discharge pipe and shot overboard clear of the ship's side, without noise, dust or dirt. The discharge of the gun is 7 in. dia., and the inlet a little smaller, so that clinkers that can enter the opening are sure to be discharged. For vessels running on rough waters, the gun is fitted with an outboard valve at the muzzle to prevent the water entering the gun when the vessel rolls, and so getting down into the fire room. For sea-going vessels a gun fitted with a hopper instead of a shelf can be supplied. When not in use the hopper can be made watertight with a lid and rubber joint. This apparatus takes up very little space, and can be readily installed in any



MECHANISM OF ASH GUN.

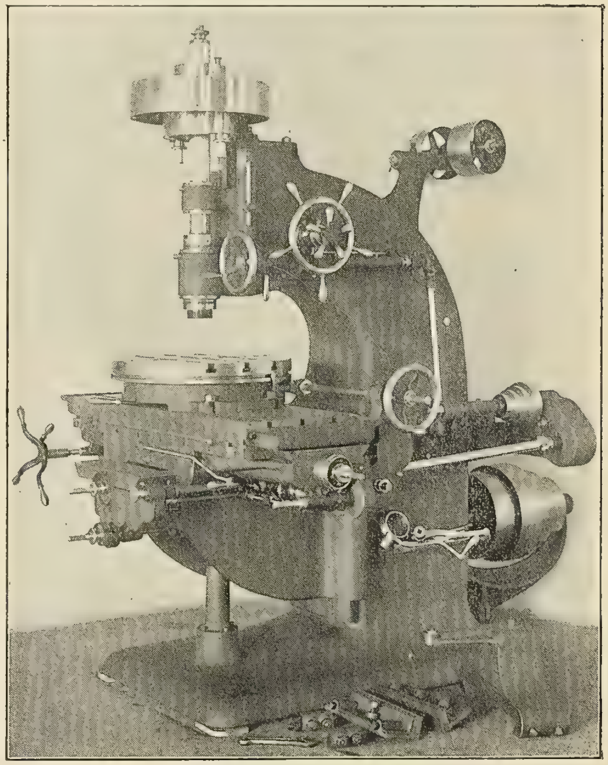
steamship. It is very rapid in operation, and the ashes are carried clear of the ship's side, thus avoiding damage to paint. The ash gun is manufactured by the Detroit Shipbuilding Co., Detroit, Mich.

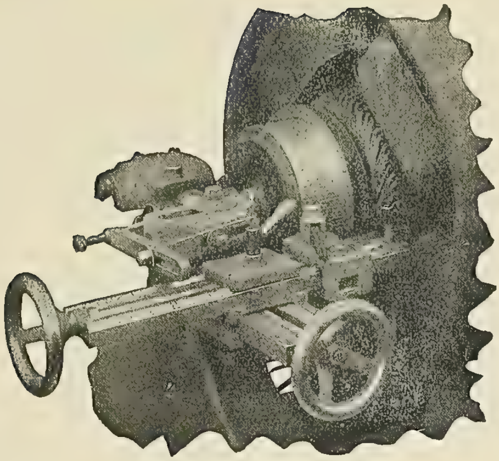
Becker Milling Machine.

In the engraving of the Becker milling machine an improved form of machine tool is shown, which takes in a wide variety of work. It is very carefully built, and has well proportioned wearing parts. The spindle has large bronze bearings made adjustable for wear, the diameter at the main bearing being 3 in. Mills are secured rigidly by means of a draw bar, and large surface mills are fitted to the threaded nose of the spindle. The spindle driving pulley is mounted upon an adjustable auxiliary bearing, and is back-geared 5 to 1—the back gears are in duplicate to balance the action. The head has an automatic or hand movement of 9 in. and an automatic stop-dog which will throw off the feed at any point within the limit of its vertical movement, thus making this machine an excellent vertical boring machine. A micrometer stop gauge is fitted so that the depth of cut can be accurately adjusted. The platen is 51 1-2 in. long over all and 14 in. beam with 42 in. automatic feed in either direction, and is fitted with quick return motion geared 3 to 1. Of the same length as the platen is the saddle with automatic feed in and out of 16 in. The feed screws are fitted with accurately divided dials. The knee has an automatic vertical feed, and has a range which gives 21 1-2 in. in the clear between the spindle and platen and 16 in. between the spindle and the rotary table. This table is 22 in. dia., graduated on the periphery and fitted with adjustable dogs to trip the feed. Table feeds are derived from compounded gears, giving eight changes for each change of spindle speed, and by a further arrangement of gears sixteen changes of feed can be made for the rotary attachment. One advantage of this type of machine lies in the fact that the cutter and the work are always visible and easily accessible. By the use of special cutters much work can be done on this machine (recessing for example) which could only be accomplished on the lathe or planer, at far greater expense, and, of course, an infinite variety of work can be done with one setting. The machine is very solidly built, weighing about 5,000 lb. It occupies about 270 cu. ft. of space. Each machine is fitted with an automatic oil pump and all the usual attachments. It is manufactured by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Commutator Truing Device.

A compact apparatus for truing up commutators of electrical generators is here illustrated. By the use of this apparatus the work can be done without dismembering the generator and removing the armature to a repair shop. In the engraving the apparatus is shown secured in position on a dynamo with the tool set for a cut. It is put in place by removing the cap of the bearing on the commutator side of the dynamo and clamping on the machine. This in construction is similar to a lath slide rest with both parallel and transverse motions. The tool post is of the ordinary type, with steel set screw for holding the tool fast. To prevent end play in the commutator when truing, the apparatus is fitted with an arm in which a threaded centerpoint is carried; this engages in the end of the armature shaft and holds it hard against the pulley end. For the best work a commutator speed of from 200 to


BECKER MILLING MACHINE.

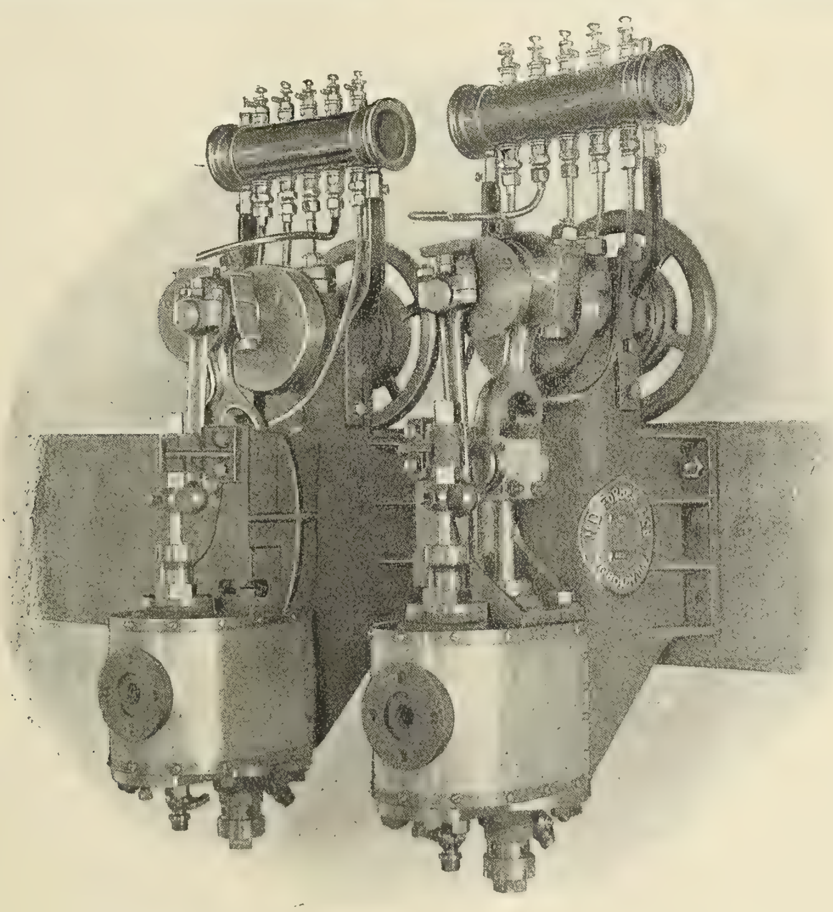


COMMUTATOR TRUING DEVICE.

250 ft. a minute is found desirable. The apparatus is manufactured by the Akron Electrical Mfg. Co., Akron, Ohio.

Circulating Pump Engines.

In designing and building the torpedo boats now on the stocks in the United States, it has been the desire of the Navy Department and the builders to as far as possible cling to well-accepted designs, modifying what has been well proven in the past to be of value to meet new conditions, thus practically eliminating in many cases the possibility of disaster. Private firms all over the United States have been aiding the Government in this respect by getting up special designs for auxiliaries, which the builders of torpedo boats have not taken in hand themselves. One of these designs is shown herewith. It represents a pair of small circulating pump engines built for the W. R. Trigg Co., of Richmond, Va., by W. D. Forbes & Co., of Hoboken, N. J. These engines are directly connected to the circulating pump shafts and although extremely stiff and strong are quite light, weighing only 135 lb. each. Their cylinder dia. is 4 in. and the stroke is 3 in., and they are capable of running up to quite high revolutions, say 600 or a little over, but, of course, as they are to be used with a circulating pump they will probably be run at very much less speed. These engines are fitted with relief valves on both ends of the cylinder, and these valves are large enough to relieve the cylinder very quickly, even if considerable water is trapped in the cylinder. A piston valve is used, which works in a liner in which the steam ports are milled. The crosshead pin is of tool steel hardened and ground, and regular navy material, as specified by the Bureau of Steam Engineering, is used throughout. The oiling device has been very carefully considered and the crank pin is oiled from the interior, the oil dripping into a circular groove in the back of a disk crank and being thrown out into the pin by centrifugal action.



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MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

AN International Congress of Naval Architecture and Marine Engineering under Government auspices will be held at the Paris Exposition, commencing July 19 next and lasting three days. The Commission of Organization includes the leading representatives of the profession in France: M. de Bussy, inspector general of the reserve fleet, is president; MM. Bertin, Dagmard and Normand vice-presidents, and the other members are equally well known in engineering circles. The Commission has extended an invitation to all engineers, constructors of vessels, and motive and mechanical apparatus of all sorts employed in marine work, producers of materials employed in marine construction, and to yatchsmen, amateurs and others who are interested in the progress of marine construction and propulsion (locomotion maritime), to present to the Congress the result of their experiences, studies and researches. This they can do either by furnishing communications which will be read and discussed at the meetings, or by taking part personally in the discussions, or they will be welcomed as auditors pure and simple. Those who desire to participate in the Congress are requested to send their names and addresses, and profession or calling, without delay, to M. Borja de Mozota, administrateur du Bureau Veritas, Trésorier, Place de la Bourse, 8, Paris, France, together with a remittance of 15 francs, which is the price of membership. On the acceptance of this fee the member will receive a personal card of entry to the Congress and will also be entitled to receive the report of the proceedings. To extend its sphere of influence the Commission of Organization has appointed a committee of leading members of the profession throughout the world, and has at this time received a large number of acceptances which include: United States, Chief Constructor Philip Hichborn, U. S. N., Engineer-in-Chief George W. Melville, U. S. N., Clement A. Griscom, president, S. N. A. & M. E., and Charles H. Cramp; Britain, Lord Hopetoun, president, I. N. A., Chief Constructor Sir William White, R. N., Dr. Elgar, Lord Brassey and others; Germany, Carl Busley, Herr Blohm, of Blohm & Voss, Otto Schlick, and others; Italy, Sig. Soliani; Spain, Senor de Haro; Russia, Col. Gonlaieff; and other states by authorities. An effort has been made by the Commission of Organization to classify the different papers, and to this end it has arranged for the following separate sections: Section A, Naval Architecture; Section B, Construction of Hulls; Section C, Construction of Marine Machinery; Section D, Classification of Types of Vessels; Section E, Facilities for Loading Vessels in Port; Section F, Miscellaneous. Already a number of important papers have been arranged for, the list of titles and authors being as follows:

BERTIN Directeur du Génie Maritime, Paris, France.
STABILITY OF A PACKET AFTER COLLISION AT SEA AND SUBSEQUENT MEANS OF PRESERVATION.

BILES Professor Naval Architecture, University of Glasgow, Scotland.
STANDARDIZING THE RESULT OF SHIP CALCULATIONS.

BONNET Engineer, Havre, France.
USE OF THE METERINTEGRATOR IN CALCULATIONS FOR THE STABILITY OF SHIPS.

CHACE Civil Engineer, Newport News, Va., U. S. A.
SHIP BUILDING PLANT AT NEWPORT NEWS.

CLARK Engineer, London, England.
FLOATING DOCKS.

DEGREMONT-SAMADEN Engineer, France.
PRACTICAL LUBRICATION.

DRZEVIECKI Engineer, Paris.
THEORY OF SCREW PROPELLERS.

GONLAIEFF Constructor Russian Navy, St. Petersburg, Russia.
PROTECTION OF HULLS AGAINST ATTACK BY RAM AND TORPEDO.

HAUSER Naval Engineer, Paris, France.
ADOPTION OF A RATIONAL SYSTEM OF UNITS IN NAVAL CONSTRUCTION.

HOLZAPFEL Engineer, London, England.
FIGHTING SHIPS OF THE FUTURE.

ISAKSON Lloyd's Inspector, Stockholm, Sweden.
NOTES ON THE TONNAGE LAWS OF THE VARIOUS COUNTRIES.

JAQUES Member Council S. N. A. & M. E., Boston, Mass., U. S. A.
ARMORED SUBMARINE BOATS.

DE KODOLITSCH Austrian Lloyd's, Trieste, Austria.
THE USE OF A GRAVING DOCK FOR MODEL TRIALS.

LABAT Engineer, Bordeaux, France.
FORMULA FOR PRE-DETERMINING THE SPEED OF VESSELS—MARINE RAILWAYS.

MOISSENET Engineer, Cherbourg, France.
TOWING MACHINES AND APPARATUS FOR STEEL TUGS.

MONTUPET Engineer, Paris, France.
MARINE BOILERS.

MULLER Captain, Paris, France.
THE EVOLUTION OF FRENCH SAILING VESSELS DURING THE PAST THIRTY YEARS.

RATEAU Engineer, Paris, France.
THEORY OF SCREW PROPELLERS.

RENNER Engineer, Cologne, Germany.
ELECTRICAL EQUIPMENT OF SHIPYARDS.

ROTA Naval Engineer, Rome, Italy.
THE RESISTANCE OF HULLS.

TROMP Ex-Artillery Officer, Rotterdam, Netherlands.
SUBMARINE BOATS—COMPARATIVE STUDY ON SCHEDULES OF WEIGHTS FOR WAR VESSELS.

TURC Lieutenant Mediterranean Squadron, France.
NON PITCHING AND ROLLING HULLS.

Those who intend to present communications are urged to send a prompt notification to M. Hauser, ingénieur de la Marine, en retraite, Secrétaire général, rue Meissonier, 4, Paris, France, giving the subject of the proposed paper. The papers themselves are to be accompanied by a brief résumé, and statement of conclusions reached, and are to be sent in not later than June 1 next. After that date they will be received for presentation to the Congress only upon the special recommendation of the Commission of Organization. Authors of such communications who will not be able to attend in person can have the papers presented by some other member of the Congress by notifying the Commission of Organization to that effect.

IN these pages we recently referred to an announcement concerning Columbia University, which was very widely published in the press of the country, to the effect that President Seth Low "shared the opinion of the faculty that it is highly important for the University to pre-empt the field of Marine Engineering without delay." We have received from F. R. Hutton, Professor of Mechanical Engineering of Columbia University, a letter in which he takes upon himself the responsibility for the document from which the published extract was made. This document—prepared for the information of the Trustees of the University—was prepared, says Prof. Hutton, "without any reference whatever to the excellent and creditable work done outside of New York," and the pre-emption expressed referred exclusively to the field in and around the port of New York. "The location of Columbia University in the port of New York, with the Navy Yard and the great Trans-Atlantic companies at its doors, makes this field," in the opinion of the College authorities, "a field of immediate availability, and would constitute for Columbia University an element of great strength in these courses." Prof. Hutton advises us that the University has secured the services of Prof. William Ledyard Cathcart as a professor of the Department of Mechanical Engineering, "having in this action a definite purpose with respect to the inauguration of the Marine Engineering and Naval Architecture courses, as soon as the time should be ripe." Prof. Cathcart received his professional training at the Naval Academy, and was a member of the late Engineers Corps of the United States Navy. Other educational facilities at the port of New York, for students of Marine Engineering and Naval Architecture, are soon to be provided by the New York University as a department of the School of Applied Science. The location of this school in the buildings at University Heights, not far removed from the shipyard at Morris Heights, on the Harlem River, is considered as an advantage, giving the students an opportunity of conveniently witnessing the practical construction of vessels. The new department will be under the guidance of Prof. C. C. Thomas, a graduate of Leland Stanford and of the School of Marine Construction, at Cornell University. Since graduation Prof. Thomas has been engaged in the practice of his profession in shipyards on the Lakes and the Atlantic Coast.

AT Cincinnati, Ohio, May 15 to 18, the forty-first meeting of the American Society of Mechanical Engineers will be held. Technical sessions will commence on Wednesday morning, May 16. About a dozen papers, on subjects relating chiefly to land practice, will be read at the meeting and discussed. Excursions to local manufacturing establishments are arranged for, and indoors the social features include a reception and conversazione. There are many important workshops and engineering plants in the vicinity of Cincinnati which can be easily reached.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—VII.

BY DR. WILLIAM FREDERICK DURAND.

§4. BOILER SCALE. (Continued.)

Scale Prevention, Salt Water.—Turning now to boilers in which sea water may form a portion of the feed, it will be of interest to first note briefly the historical development of the modern situation.

In the early days of marine engineering, the temperature and pressure of the steam were low, and the jet condenser was in general use. The feed water which was drawn from the mingled condensing water and condensed steam was but slightly fresher than sea water, so that large amounts of solid matter were thus fed into the boiler. In consequence the density would have risen rapidly had it not been kept down by blowing off a part of the water in the boiler of relatively high density, and replacing it with the salt feed of lower density. Had the sulphates of calcium and magnesium thus brought into the boiler been completely deposited, enormous quantities of scale would have been formed, and this method of operation would have been quite impracticable. Due, however, to the moderate pressure then in use and to the fact that the density was kept usually between 1 3-4 and 2, the salts were held fairly well in solution, and but a moderate amount of scale was deposited.

As steam pressures advanced, however, beyond 40 or 45 lbs., conditions were reached under which first the calcium sulphate and later magnesium sulphate and other salts are completely deposited. Under such circumstances blowing off to reduce the density of the water will only make matters so much the worse, for the lower the density is to be maintained, the greater must be the amount blown off, and hence the greater the amount of extra feed, and the greater the amount of scale forming salts brought into the boiler, all of which will be deposited.

It became therefore necessary to abandon the use of the jet condenser and salt feed. Its place was taken by the modern surface condenser. So long as this condenser is perfectly tight the feed water consists of the condensed steam, and is therefore almost perfectly fresh water. Due, however, to steam leaks at the various joints, seams and glands, to the occasional use of the steam whistle, and to the use of steam in certain auxiliaries from which it is not returned to the condenser, there will be a continual shortage in the feed water which under usual conditions will be found between say 2 and 5 per cent. Until recent years this shortage was made up by the use of sea water obtained usually by opening, as circumstances required, the ***salt water cock*** connecting the salt water side of the condenser with the steam side. It is very difficult to keep the tubes of a surface condenser packed perfectly tight, and in some cases the condenser was allowed to run a little leaky, simply to make up in this way the salt feed required.

Due to this admixture of salt feed, the scale forming salts of which are all deposited in the boiler, there will be a gradual formation of scale greater or less according to the length of the run and the proportion of salt feed make up.

In recent years experience has clearly shown that the dangers of overheating and the general bad effects due to the presence of scale are more and more pronounced as the pressures are higher. It has become therefore more and more important to prevent so far as possible the entrance of any sea water into the boiler, and thus avoid the formation of scale with its troubles and dangers. To this end, in modern practice, the make up feed is provided by an evaporator or in some cases by feeding one boiler with salt feed and thus restricting the scale formation to this boiler, while the condensed steam from all the boilers is returned to the other ones as feed. In all such cases it will be noted that this scheme amounts to a transfer of the use of salt water and the formation of scale from the boilers in general to the evaporator, or to the particular boiler in which it is allowed to accumulate.

It is rare that the condenser can be maintained perfectly tight, so that even under the best practicable conditions there is apt to be some passage of sea water into the steam side of the condenser, and thence into the boiler. Under the best conditions the amount of scale formed, however, is so small that commonly no special treatment is attempted, and the scale is allowed to deposit, and is then removed at the regular periods of inspection and overhaul.

Some attempts have been made to prepare sea water by the removal of the calcium sulphate in a separate vessel before entering the boiler. This may be done by the use of sodic fluoride which causes the sulphate to separate out and settle to the bottom as a fine powder. The remaining water is practically free from this substance and may be used for boiler feed without fear of causing scale.

Soda ash and other alkalies have sometimes been used in boilers, with feed water containing sulphate of lime. They act by converting the sulphate into a carbonate, and thus into a somewhat less objectionable form.

Barium chloride acts in a somewhat similar fashion by producing barium sulphate and calcium chloride.

The use of zinc in boilers is also by many believed to prevent to some extent the formation of scale by the reaction of the alkaline zinc chloride on the scale forming salts.

With sea-going as with inland boilers the bottom blow should be used occasionally and as the particular circumstances may demand, so as to remove the accumulation of such substances as may be thrown down as a powder or sludge and thus collect in the bottom of the boiler.

However careful the provisions for keeping sea water out of the boilers or no matter what methods may be used to prevent scale formation, it is almost sure to gradually accumulate, and assurance of safety from the troubles and dangers which may result can only be obtained from periodical examination and scaling as may be found necessary. All marine boilers must, of course, be provided with manhole plates for this purpose, and the internal arrangement of tubes, braces, furnaces, etc., should be made, so far as possible, with a view to furthering this necessary operation.

Combinations of Oil and Scale.—We have thus far referred to scale formed simply from the solid matter in the feed water. The combinations which may be formed by the deposited salts and oil from the cylinders as it

may enter with the feed water are, however, of even still greater importance, and must now be noted.

Oil coming in thus with the feed water is caught by the circulating currents and distributed more or less throughout the boiler, though by reason of its lesser weight it will tend gradually to rise and accumulate as a scum at the surface of the water. In thus wandering about, a drop may come in contact with a bit of solid matter separated from the water. The two join together, the oil forming a coating about the sulphate, and they journey on meeting and joining with other like particles. The combination of the oil and sulphate may have about the same specific gravity as the water in the boiler and hence these particles will readily move with the circulating currents, either up or down, as they happen to be flowing. They are thus swept along the heating surfaces, to which they attach themselves all the more readily by reason of their oily covering, and on either the upper or lower side as they happen to be moving with a down or up flowing current. In this way the coating gradually increases until it has attained a thickness sufficient to seriously interfere with the passage of the heat.

In other cases when the scale and oil are lighter or the water is denser and heavier, there seems to be formed at the surface of the water in the boiler a kind of oil and scale blanket or layer floating about and perhaps ultimately by the gradual increase of weight sinking and covering some portion of the heating surface. Especially is this oil "pancake," as it has been called, liable to settle should the density of the water in any way be suddenly decreased. Still otherwise should the boiler be blown down by the bottom blow, such an oil blanket would naturally settle and attach itself to some part of the heating surface. Should the boiler be then filled again, the coating would remain where attached. This shows that under such circumstances a boiler should never be blown down with the bottom blow without first using thoroughly the surface blow to remove as far as possible all such accumulations of oil or of oil and scale from the surface of the water.

The danger to be feared from this combination of scale and oil is not in its close adherence to the surfaces, but in its non-conductivity for heat. Experiments show that 1-16 to 1-8 inch of such a covering is far worse in this respect than perhaps 1-2 inch or more of scale alone. The danger to be feared is therefore overheating and collapse, and not a few cases of the collapse of furnaces and other parts of marine boilers are believed to be due to this cause.

So far as these effects are concerned it is seen that it is better to carry a high density in the boilers than a low one, so as to keep such oil and scale combinations at the surface of the water, where they may be disposed of by the surface blow.

As it is practically impossible to prevent the entrance of some scale forming materials into the boiler, the danger of trouble with oil and scale combinations is most surely prevented by keeping the oil out. To this end a cylinder oil should be used having a high point of vaporization, as the higher this point the smaller the amount carried into the condenser. Of this oil the minimum amount necessary should be used in the cylinders, and the feed water should be filtered to remove whatever oil it may contain.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XXIII.

BY WM. BAXTER, JR.

METHODS OF DISTRIBUTION.—CONTINUED.

Distribution, or junction, boxes are not absolutely necessary in a lighting system, whether located on board ship or on shore, but they serve to simplify the wiring, and also to facilitate the handling of the apparatus. From each junction box one or more circuits are run out, and upon these the lamps are placed. A lamp is liable to become disarranged, and while in some cases the defect may result in simply opening the circuit, so that the light will go out, in others it may produce a short circuit, and thus allow an enormous current to flow through it. On this account lamps should be provided with safety fuses that may be melted by an excessive current, and thus protect the generator, as well as the line wires, from the effects of such currents. To provide each lamp with a fuse would entail an unnecessary amount of complication, hence the proper procedure is to provide one fuse for each individual lamp circuit, then this single fuse will protect the circuits and generators against damage arising from the disarrangement of any lamp in that particular circuit. If the individual lamp circuits issue from junction boxes, the fuse can be placed therein, and then when anything goes wrong with the lights the attendant knows where to look for the trouble. If distribution boxes were discarded, main lines could be run on either side of the ship, and the lamp circuits could be taken off from these at convenient points. With such an arrangement, however, the fuse would have to be unprotected, and every time they were blown out the melted metal would spatter over surrounding objects, and the flame would char and disfigure the surfaces to which they were attached, and possibly set fire to them.

The system of distribution would be the same, electrically, whether we used junction boxes or not, but mechanically the difference would be that the junctions of the main distributing lines and the lamp circuits would in one case be exposed, and in the other they would be covered. From this we can see that a junction, or distributing box, is nothing more nor less than a covering for the portion of the circuit wires where the branch circuits are connected with the main lines. If we had an unprotected system of wiring, we would place in the individual lamp circuits a switch, by means of which the current could be turned on or off as desired, if such an arrangement were necessary, and, likewise, if we use the protective system, that is, junction boxes, we will provide a switch whenever required. As the junction boxes are an additional expense, it is natural to endeavor to get as much good out of each one as possible, hence we make an effort to so arrange the wiring that a number of lamp circuits may start from the same point, and thus we increase the usefulness of each box, by making it a center from which several branches issue.

If it is not necessary to arrange the lamp circuits so that they may be cut out individually, then the distributing box can be made comparatively small, as it will only have to be of sufficient size to accommodate the fuses, but if switches are also to be provided, the

dimensions will have to be increased, and in that case if the space available for the junction box is not sufficient two boxes located at different points will have to be provided. It is not necessary to locate the switches of the lamp circuits in the junction boxes, and in many cases it is more convenient to place them else-

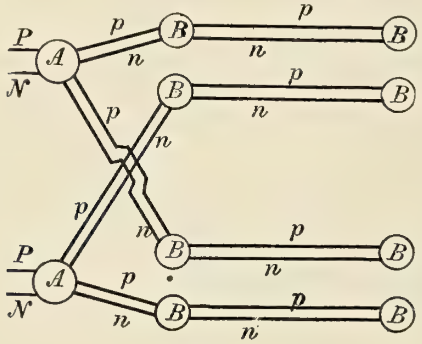

FIG. 153.

where, as for instance, when the box is located in an inaccessible position; hence, even when all the lamp circuits are provided with switches, we can use a compact junction box as a center for a number of circuits by using separate switches, located at other points.

In every system of wiring for lighting purposes it is desirable to arrange the circuits so that any mishap to one may disturb the lights as little as possible. The best way of securing this result is by using a double or triple system of distribution. A double system is one in which every part of the ship, where practicable, is supplied with lights by two independent sets of circuits, and in a triple system three independent sets are provided. With the double system, if the lights operated by one set of circuits go out through some disarrangement of the wires or connections, the lights burning on the other system will still be left in service, and although the illumination will be reduced there will not be total darkness. The general arrangement of a double system is shown in Fig. 153, in which, as will be

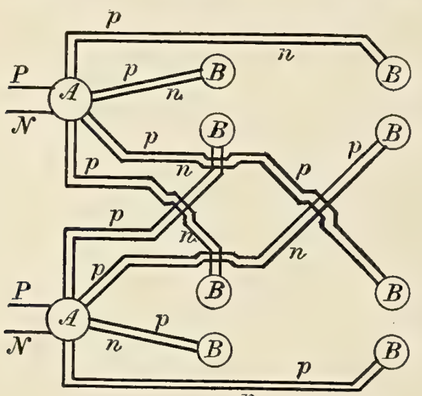

FIG. 154.

seen, the two main distributing boxes, *A A*, feed into four secondary boxes, *B B B B*. These secondary boxes are shown side by side, and all of them are bunched close together, but it must be understood that in actual practice they would be widely separated. The boxes shown in pairs indicate those used to light up the same section of the ship. In some instances the pair of boxes is replaced by one, in which case the circuits running from the two main boxes, *A A*, are run into it. This arrangement is not as perfect as that involving the use of separate boxes, for a disarrangement of the switches or other apparatus belonging to one circuit might be so extensive as to affect the other, and thus defeat the object of the double system.

Fig. 153 does not show the best arrangement of a double system, for the reason that the *B* boxes are not entirely independent of each other. As will be seen, there are only two circuits run out from each *A* box, and the secondary boxes are connected two in series in these circuits; therefore, the failure of the first of these boxes might disable the second one. A far more complete arrangement is shown in Fig. 154, in which each

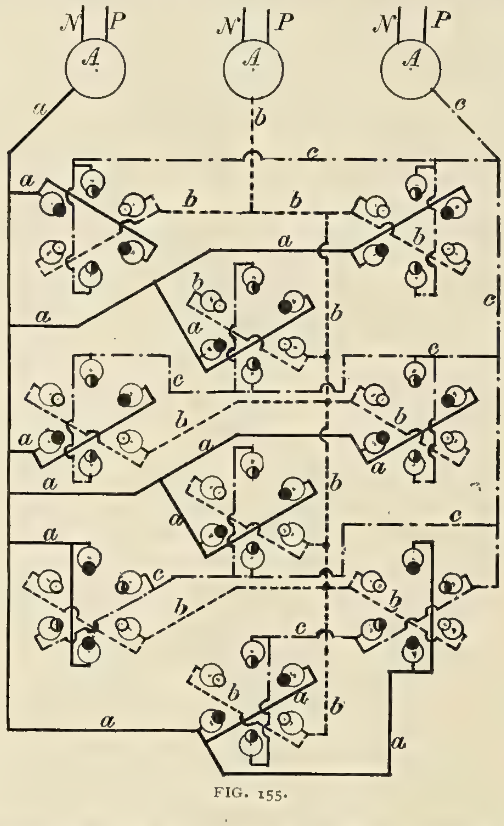

FIG. 155.

secondary box, *B*, is connected with the primary box by an independent set of wires; hence, the failure of one box will not impair the usefulness of the others.

Fig. 155 illustrates the manner in which a triple system is connected with the individual lamps. These lamps may be assumed to represent nine small electroliers, illuminating, say, a dining saloon. For the sake of simplicity the circuits running from the junction boxes, *A A A*, to the lamps are represented by single lines, but this representation is correct if we keep in mind that two wires are run along each line; in other words, we can regard the lines as representing double wire cables. To make the illustration more accurate, we have shown the cables branching out into two wires at each lamp. The circuit running from the box at the left is shown in solid lines, and that running from the right hand box is drawn in dash and dot lines, while

the circuit from the center box is shown in dotted lines. Each box feeds two lamps in each electrolier, those connected with the left side box being shaded, those operated by the right side one being half shaded, while the white ones are connected with the center box. From this disposition of the circuits it will be seen that the failure of one of the boxes will only put out two lights in each electrolier. It will also be noticed that if we cut out one circuit we effect a uniform reduction of illumination throughout the entire room, which is more satisfactory than darkening one part and leaving the rest brilliant.

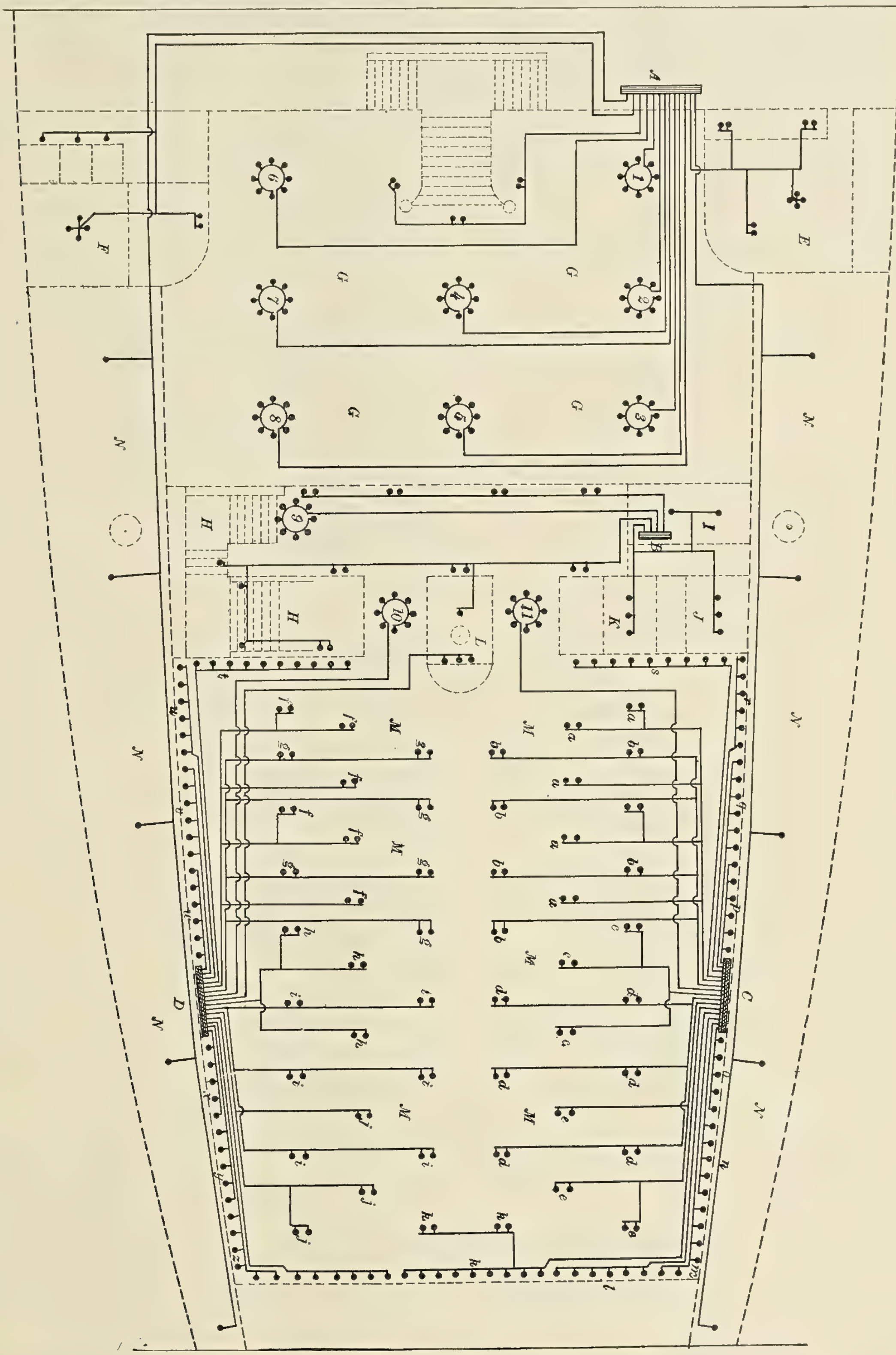

FIG. 156.

As a final example of the general method pursued in wiring, we give the illustration, Fig. 156, which shows the arrangement of lights and wiring for the dining saloon and adjoining parts of the vessel. This drawing is but a slight modification of the actual construction used in one of the large steamers running on Long Island Sound. The whole system of lamps is supplied from four distribution boxes marked *A B C D*. The first one supplies the lights in the saloon, *G G G G*, and also in the side rooms, *E* and *F*, and the outside lights at *N N N N*. The box *B* feeds the lights for the stairway, *H H*, the cashier's office, *L*, and the butler's rooms, *I J K*. The box *C* supplies one side of the dining saloon, and box *D* takes care of the other. Box *A* runs out 13 lamp circuits, box *B* furnishes four, and boxes *C* and *D* each supplies fifteen circuits. The lamps burning on the same circuit are marked with the same letter.

The outlines of the boat are drawn in broken lines so as to cause the circuits to stand out more boldly, and, as in Fig. 155, the wiring is represented by single lines. The boxes *A*, *C* and *D* should be connected with the switchboard by at least two circuits, each one supplying its proportion of the lamp circuits. With two circuits from the switchboard, box *A* would be arranged with electroliers *1 3 4 8 7* and lights in room *F* connected with one circuit, the other circuit being connected with the balance. Of the lamps supplied from box *C*, the groups *a c e k m o p* and *r* should be connected with one circuit and the remaining ones with the other. The lights fed from box *D* should be arranged in the same way. These boxes should be provided with switches by means of which the lamp circuits could be connected with either circuit coming from the switchboard, then in the event of the failure of one circuit all the lights could be operated by the other.

ENGINEERS' DICTIONARY.—XXVII.

Lock Bolt—A bolt used to lock or secure some part of a mechanism so that it cannot become loose by jarring or pounding. See also under *Bolt*.

Lock-Nut or **Jam-Nut**—See under *Bolt*.

Low-Pressure—In a compound or multiple expansion engine, where the steam is expanded in stages through a series of cylinders of increasing sizes, the *low-pressure* cylinder is the largest and last of the series, and from this the steam goes to the condenser. The term *low-pressure* is also sometimes used in referring to a condensing engine as opposed to a high-pressure or non-condensing engine, and in a vague and general sense in referring to any machine or method of operation in which the pressures involved may be relatively low.

Lubricator—In general, any device for applying oil or other lubricant to a bearing or place where required. In particular, a device for feeding cylinder-oil into the steam pipe or throttle valve chamber, where it may be caught by the steam and carried on to the valve chests and cylinders. The essential parts of a lubricator are a small vertical pipe attached at its upper end to the steam pipe, and at its lower end to the chamber containing the oil, the latter being connected to the steam pipe or valve chamber. Steam is admitted to the vertical pipe, where it condenses, thus forming a vertical column of water connecting to the bottom of the oil chamber. The pressure upward of the water against the oil is therefore equal to the steam pressure plus the pressure due to the head of water in the vertical pipe. The pressure opposing the flow of oil into the steam pipe or valve chamber is on the other hand practically that due to the steam. The extra pressure due to the head of water is therefore available for forcing the oil out of the chamber and into a passage leading to the steam pipe. By this means, as controlled by a regulating valve, the oil is forced, drop by drop, out of the oil chamber at the top, the water entering at the bottom gradually taking its place. A small gauge glass is placed on one side to show the level of the water and oil within the chamber, while a short length of glass tube filled with water forms a part of the passage followed by the oil drop. Its passages upward through the water is plainly visible, thus showing clearly that the apparatus is working properly. Such an attachment is called a *sight-feed*, and the whole device a *sight-feed lubricator*.

Lug—An extension or projection of metal from the main body of the part, thus providing a means of connection or fastening of one part to another.

Main Bearing—A name frequently given to the crank-shaft bearing or pillow-blocks.

Main Steam Pipe—The main line of steam piping from the boiler to the engines, as distinguished from the various auxiliary pipes and connections.

Manhole—In general a hole or opening cut to allow the passage of a man. Thus a manhole in the shell of a boiler is an oval or elliptical hole cut to allow the entrance of a man to the interior of a boiler for purposes of examination and repair. The usual size of a boiler manhole is 11 in. by 15 in. Similar openings may be made in the shell of a condenser, and also in the inside skin and throughout the inner structure of a ship's "double bottom." Circular openings with suitable covers are also frequently provided in the heads of large steam engine cylinders for like uses.

Manhole Cover or Plate—A cover fitted over a manhole and secured by bolts or dogs, with suitable arrangements for a steam or water tight joint as the case may require. In fitting a cover to a boiler manhole, a reinforce ring is secured about the hole in order to provide local strength and stiffness, and when the hole is cut in the curved shell, to restore in some measure the metal removed by the hole. In some cases —hand or mud holes—the reinforce metal is obtained by flanging the plate around the hole.

Manifold—A pipe or chamber serving to connect together in common a large number of pipes or tubes. Manifolds are used in the construction of many forms of water-tube boiler, and also in forming steam heating and refrigerating coils, etc.

Mean Pressure—The mean or average of a series of varying pressures. Thus, we may refer to the mean pressure on a bearing surface, the mean pressure on a piston, etc.

The U. S. training ship *Buffalo* will leave one of the Atlantic ports shortly with several hundred landsmen on an extended cruise. The first port of call will be, probably, Gibraltar.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—I wish to get out a triple expansion engine design, and would be obliged if you would outline the work from the beginning, giving what should be first known and the order of procedure. J. W. H.

A.—In the design of a triple expansion engine for marine work a great number of questions must be considered before calculating dimensions and proportions. Weight, space occupied, grade of material and the nature of the service of the engine will all be factors having an important bearing on the design. A torpedo boat engine made of the finest material, with high piston speed and not a pound of surplus metal in its construction, is quite a different affair from the engine of the ordinary cargo boat, although both of them may develop the same power.

It would be impossible in this answer to go into details of the different types, the question of cylinder proportions, valve setting and crank sequence, as opinions differ considerably on these matters, and experience usually decides the details adopted. In designing parts, etc., a good book of rules such as Seaton & Rounthwaite's pocket book of marine engineering would be of great value.

In the draughting rooms of most of the engine building concerns, the design of a new engine usually consists in remodeling and altering the plans of engines previously built with the view of using old patterns of parts, and in this manner the design can be produced very quickly. In an original design, however, it is an affair which takes considerable time. To give a short synopsis, the following is the usual method of procedure :

After determining the power necessary to propel the vessel at the required speed, the propeller wheel is designed or decided upon, in which case the assumed slip, diameter, and pitch will determine the number of revolutions per minute of the engine. Then on deciding the piston speed, the stroke of the engine can be calculated, and the stroke, revolutions, horse power and boiler pressure being known, the diameters of the cylinders can be computed. Then the different port areas and valve settings are figured.

After deciding upon the type and position of the valves the design can be started, by drawing out separately each cylinder with its parts, valve and stem, cover, piston and stuffing box. Beneath each cylinder sketch its crank shaft with the bearings and eccentric sheaves, taking care to see that there is room to remove coupling bolts, eccentric sheaves, etc. Then the distance between centers of cylinders can be decided upon.

Next decide on the style of crosshead, guide shoes, connecting rod and crank pin box, and make a separate end view of these, showing the crosshead in the top and bottom positions, and the angles of the connecting rod at different portions of the stroke. By this means the position of the guide faces are determined in relation to the crosshead and connecting rod, and allowing the necessary clearance between the stuffing box and crosshead in the top potition the end view of a cylinder may be sketched in. The center of the shaft is then a fixed point.

Now show the crank pin box in different positions of the stroke and thereby determine the size of the crank pit, bearing in mind that in this case, as well as for all other parts, there must be room left for overhauling or taking parts adrift. The shape of the bed plate can then be worked in, and this will be determined by the shape of the bottom of the ship, or tank top, or stool to which it is to be fastened.

Next the positions of columns and their attachment to the cylinders and bed plate can be considered, giving them all the same slope, and if possible making them all duplicates of each other, so that the same pattern can be used with minor alterations for each. Next design the valve stem guide brackets, then the butt ends of the valve stems, the saddle blocks and links.

A separate sketch can then be made showing the different positions of the link at various points of the stroke, and after determining the clearance between the link in its highest position and the valve stem guide the length of the eccentric rods can be ascertained.

Next determine the centers of the drag links, rock shaft levers, and of the rock shaft itself, by placing the link in the ahead and in the astern positions. Locate the rock shaft so that it can be conveniently attached to the columns.

All these plans can then be combined, and the arrangement of the condenser drawn in. The condenser is usually made about the same length as the engine, if attached to the bed plate, and care must be taken that the drain is sufficiently high above the air pump suction. There are so many designs of condensers that it would be impossible here to give any details, and this applies also to the minor engine attachments.

Q.—Can the speed of vessels be increased by twin screws over that attained by a single screw? If so, what percentage gain in speed?

I have a single screw propeller on a yacht 65 ft. long and have attained a speed of 12 miles per hour, developing 60 H. P. Could the speed be increased with twin screws and two engines developing 30 H. P. each?

The propeller now used is 38 in. dia. and 60 in. pitch.

The speed of 12 miles was with 300 revolutions per minute and with a loss in slip of about 30 per cent.

A. D. R.

A.—The whole question turns on whether or not you can apply your total power of 60 I. H. P. more efficiently with two screws than with one. To judge of this point we should require somewhat fuller information than is given regarding the single screw. Making the best use of what is given, however, and examining the performance of the single propeller of 38 in. dia. and 60 in. pitch at 300 revolutions and a speed at 12 miles per hour, it appears from the most reliable propeller formulæ that it should be able to take care of about 60 I. H.P. with a very fair efficiency—within a few points probably of the best that could be gotten from any propeller. It follows therefore that with the propeller you are already using you are applying your power with an efficiency not far below the best that can be hoped for, and hence that you cannot expect to do very much better with twin screws and the same power.

At the same time the indications are that with twin screws carefully designed and adapted to the circumstances of the case a small increase in efficiency could be expected, and a corresponding increase in speed, but not probably greater than ¼ to ½ mile per hour. This gain, it should be noted, would not be due primarily to the use of *twin* screws rather than *single*, but simply to a slightly better design and adaptation to the circumstances of the case. Quite as good results could undoubtedly be gotten from a single screw slightly modified in size and proportion, assuming of course that there are no special limitations to the diameter, revolutions, etc.

In other words the question does not turn on whether one screw or two are employed, but on how correctly they are designed to meet the circumstances of the case.

Referring again to the case in hand, it is therefore very doubtful if the change from single to twin screws would be justified by the expectation of any really considerable increase in speed.

It must be remembered that this opinion is based on the supposition of equal power given to both twin and single screws. If it were desired to considerably increase the power and there were limitations on the diameter of the propeller, then it might become advisable to change to twin screws to avoid loss at the higher powers.

M. Marcel Delmas, 10 Boulevard Emile Augier, Paris-Passy, has charge of the Report of the "Congres de Mécanique de l'Exposition universelle, in the department of applications of electricity to the various apparatus of haulage, hoisting, etc. (including cranes, elevators, winches, swing-bridges, pumps and other such mechanisms), and particularly desires information regarding the economic side of the matter. He requests that all, whether exhibitors or others, who are willing to assist in the collection of this data send him, at the address given above, statements of costs of installations, of exploitation and incidental expenses, especially where a comparison can be made with costs of the older systems under similar circumstances. All publication and illustrations will be welcome if authentic and exact in statements of facts and data.

In the Government ordnance factories at Woolwich, England, there are 25,000 workmen employed. At the Krupp, Essen, works about the same number are employed.

TECHNICAL PUBLICATIONS.

Hydraulic Power Engineering. By G. Croydon Marks. First edition, 1900. Crosby Lockwood & Son, London; D. Van Nostrand, New York. Size 6 by 8. Pages 360. With over 200 illustrations, chiefly drawings. Cloth, $3.50.

This new work is built upon the little book entitled, "Hydraulic Machinery," which the author brought out in 1891. It is a distinct gain to the profession, as there are very few good works on this subject. The author has in all cases illustrated and described the latest forms of apparatus built by the various firms who make hydraulic machinery their specialty; and has not, like some others, made use of engravings of the earlier forms from the proceedings of various engineering societies.

This is such a very useful book that we should like to see it accompanied by a more comprehensive index for purposes of ready reference; and if Mr. Marks would add more tables and formulæ for the power required in forging, flanging, shearing, etc., by hydraulic machinery he would increase the practical value of the work.

Part 1 deals with the principles of hydraulics.

Part 2 will be found very useful by the young engineer, as it deals with details of design and points out mistakes which designers are apt to fall into.

Parts 3 and 4, on Joints and Valves, are worthy of the most careful study. Many hydraulic plants have been thrown into disrepute from leaking valves and joints. A very full and complete description of the manufacture of cup leathers is here given and the necessary dies shown in detail.

Part 5, on Lifting Machinery, contains a great deal of information which will enable the student to work out the size of rams and their details. Special attention may be called to Table IX, giving Coefficients of Efficiency of Pulley Wheels Turning on Pins; and also to page 173, showing Efficiencies for Multiple Hoists. Many types of hydraulic cranes are illustrated and described in this section, and a chapter is devoted to a description of accumulators and intensifiers. If the author had been writing particularly for American engineers he would have done well to impress upon them the great advantage gained by the use of large accumulators.

Part 6, Hydraulic Presses, is very complete and many useful hints and formulæ to aid in designing are given. Chapters XIV, on Sheet Metal Working and Forging Machinery, and XV, on Hydraulic Riveters, simply illustrate and describe the latest machines used for this work. Their value would be much enhanced by the addition of practical data on the power necessary to do this work.

In Part 7, the various forms of Pressure Pumps are briefly described. Part 8, on Hydraulic Motors, deals in some detail with Turbine and Hydraulic Engines and will be found very useful.

The last chapter, on Recent Achievements, refers to the large hydraulic lift dock built by the Union Iron Works of San Francisco; the Tower Bridge, London; Water Balance Railways; the Glasgow Harbor Tunnel; Tunnel Lifts in which the large hydraulic elevators built by the Otis Elevator Co. are operated; and lastly the Niagara Power Plant is illustrated and described. The author is to be congratulated on the marked advance shown in this work, and on the very excellent manner in which it has been produced.

The Gas Engine Handbook. By E. W. Roberts, M.E. First edition, 1900. The Gas Engine Publishing Co., Cincinnati, O. Size 3 1-2 by 5 1-4. Pages 220. With 39 original illustrations. Cloth.

As its name implies, this is a little book intended for the use of persons having practical charge of gas and gasolene engines, and with a view to best serving the needs of such men thermodynamics and high mathematics have been carefully kept out. The book is a good practical discussion of the subject, giving the fundamental principles underlying gas engine operation, together with considerable practical information as to the handling of engines and remedying any ordinary troubles which may arise.

Taking into consideration the specific scope of the book, chapters 15 to 21 inclusive, relating to the dimensions of the various parts of gas engines, might profitably have been omitted to make room for advisable expansion of the chapters on practical handling. In chapter 14 there occurs what seems to be an error of reversed formulas; the formula given for the compression curve is $P V^{1.3}$ = constant, and the formula given for the expansion curve is $P V^{1.35}$ = constant. The compression curves of about twenty diagrams examined by the reviewer showed an average of $P V^{1.35}$ and the expansion curves showed the average of $P V^{1.3}$, exactly the reverse of the formulas given in the book under discussion. However, the difference is so slight and the variation from any formula so uncertain in practice, that one might take either of the values given for either of the curves without involving a very serious error.

The portion of the book relating to marine work is restricted to one page, in chapter 23, on which are given formulas for the diameter of the propeller and the capacity of engine required for small boats. The formulas for ascertaining these figures are extremely empirical and apparently crude; that for horse-power taking into consideration only the length of the boat and not its speed or displacement, while that for the diameter of the propeller is based upon the horse-power and revolutions per minute, no consideration being given to the speed of the boat. There is no discussion of gasolene or oil engines designed particularly for marine work.

Salvage Award.—Salvage services are not always as remunerative as is popularly supposed. An award of only $82,500 was made by the British Admiralty Court to the owners of the S. S. *Asloun* for rescuing the steamship *Waikato*, and towing her about 2,600 miles to port. In our issue of January last we gave details of this most remarkable rescue, performed under very trying conditions. The *Waikato* was out 157 days, and reinsurance had gone to 12 per cent., when she was brought into port by the *Asloun*. In the evidence in court the appraisal of the *Waikato* and cargo amounted to $665,000. Her crew numbered 50, all told.

MARINE ENGINEERING.

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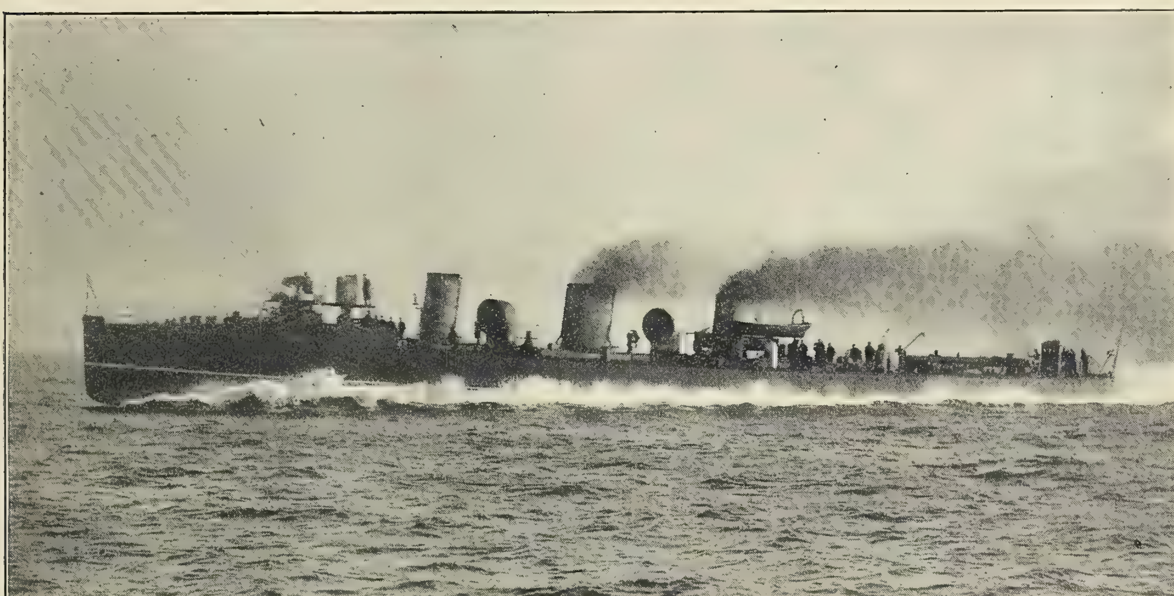
FURTHER TRIALS OF THE TURBINE DRIVEN TORPEDO BOAT DESTROYER VIPER.

In a series of runs over the measured mile carried out last month the turbine driven torpedo boat destroyer *Viper* maintained an average speed of 34.25 knots. The trial conditions were not favorable; there was a rough sea, the wind was "blowing hard," and as the boat had not been out of the water for some time previously, her under water body was rather foul.

The *Viper*, as our readers will recall, was built by Hawthorne, Leslie & Co., and was engined by the Parsons' Marine Steam Turbine Co., Newcastle-on-Tyne, for the British Navy. On her builders' trials a speed of 35 knots was attained, and she was then turned over to the navy for further trial and acceptance. It is, we understand, the intention to not only carry out acceptance trials, but to make a very exhaustive series of trials with the *Viper*, so as to get a line on the turbine method of propulsion in general. The trials here referred to were carried out by representatives of the Admiralty.

In the accompanying photograph the *Viper* is shown steaming at the rate of about 35 knots, on her preliminary trial. In dimensions she measures: Length, 210 ft.; beam, 21 ft.; depth, 12 ft. 9 in. The vessel is fitted with four separate screw shafts, on each of which there are two propellers. The inboard end of each shaft is direct connected to a separate turbine. These are fitted in pairs, and the high and low pressure turbines of the two independent sets of compound turbines are separate. The high pressure turbines are 35 in. dia. and the low pressure 50 in. dia. These main engines are for steaming "ahead" only, as they are not of the reversing type, and the sternward moving of the vessel is accomplished by the use of a separate turbine connected to one of the shafts. With the "ahead" turbines stopped and the "astern" turbine in operation, a maximum rate of speed sternward of 15 1-2 knots can be attained.



OCTUPLE SCREW TURBINE DRIVEN DESTROYER VIPER DOING 35 + KNOTS ON HER PRELIMINARY TRIAL.

In exterior appearance the *Viper* does not differ from the ordinary destroyer. She has three stacks, the middle one being larger than the other two; this is necessary, as the two center boilers are placed back to back. The boilers are of the Yarrow straight tube express type. They have 275.75 sq. ft. grate surface and 15,000 sq. ft. heating surface.

On the trials last month the contract load of 40 tons was increased to 60 tons, and the displacement is stated to have been 375 tons. Steam was maintained at press-

ures ranging from 165 to 175 lb., as higher pressure could not be carried on account of the setting of the relief valves, which lifted when the pressure was allowed to run up. The mean revolutions on the mile were about 1,050, and at the boilers the air pressure carried was about 3 in. Indicator diagrams cannot, of course, be obtained with this form of engine, but it is estimated that the horse power was not less than 11,000. After completing the runs over the measured mile, a three hours' steaming trial was successfully carried out.

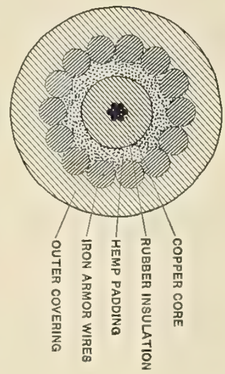
It is in the engine room, of course, that the difference between the *Viper* and the ordinary destroyer is most noticeable. Instead of the usual complicated reciprocating engines standing up in the engine room, with hundreds of moving parts in sight, there is nothing visible except the casings of the turbines and the condensers. The high pressure ends of the engines are forward, below the starting platform which stretches athwartships. There is no valve gear nor complication of starting levers, simply the stop valves on the live steam mains, by which alone the starting and stopping of the turbines are regulated.

When running at all speeds the absence of vibration, as far as the main engines were concerned, was remarkable as compared with a boat fitted with reciprocating engines. All noise and vibration was not eliminated, however, as the auxiliaries are of the ordinary type. It has been proposed by the builders to get rid of this by installing the electric drive, the generators to be driven by a steam turbine.

Results of further trials with this interesting vessel are awaited with very great interest by members of the profession in every maritime country.

CABLE CUTTING OPERATIONS OF U. S. S. ST. LOUIS DURING THE SPANISH WAR.*

BY CAPT. CASPAR F. GOODRICH, U. S. N.



SECTION OF CABLE—EXACT SIZE.

ON the 30th of April, 1898, the U. S. S. *St. Louis* left New York to scout off the island of Guadeloupe in the hope of sighting Cervera's fleet. While engaged in this duty many conversations were held by her officers as to what the ship might do during the war which would be useful to the country, and as to the various means by which our own cause could be advanced or the enemy's injured. Some one, I have forgotten now who it was, remarked that Admiral Sampson would greatly appreciate the cutting of the submarine cables leading to Cuba and Porto Rico, adding that a cable ship was now a necessary part of any well-organized fleet.

"Not at all," said Chief Officer Segrave; "there is nothing easier than to pick up and cut a cable."

At this the rest of us exclaimed: "How is it done? Can you do it?"

Mr. Segrave replied: "All you have to do is to lower a stout grapnel to the bottom and to drag it slowly across the location of the cable. If the bottom is sandy and free from rocks you can often catch the cable on the first drive. If, on the other hand, the bottom is foul, you may spend a week and not get it, even when you have special appliances for the purpose."

OUTLINE MAP SHOWING THE FIELD OF U. S. CABLE CUTTING OPERATIONS DURING THE SPANISH WAR.

It will be recalled that in addition to the *Viper*, for the British Government, another vessel of similar dimensions was constructed, the owner's identity not being disclosed. This boat, named the *Cobra*, has just been completed, and according to cable reports, she attained a rate of speed of 35.88 knots.

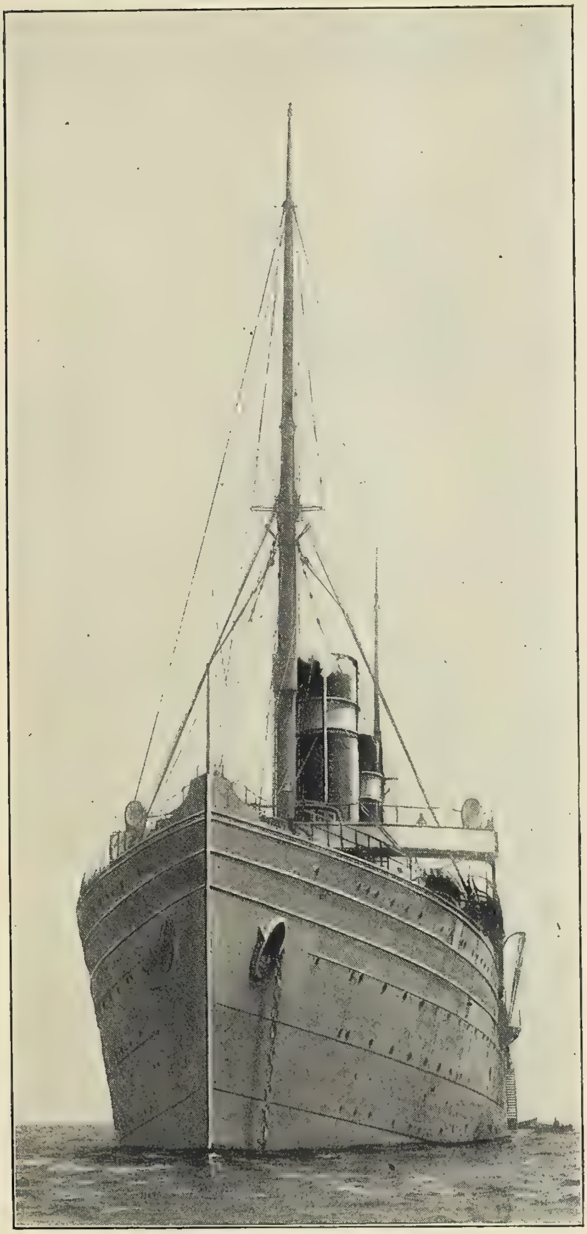
*From the *Proceedings of the U. S. Naval Institute*; Text Copyright, 900, by the U. S. Naval Institute, Annapolis, Md. Illustrated by MARINE ENGINEERING.

"How do you happen to know so much on the subject?"

"I have spent years laying and repairing cables. I have, myself, laid some of the cables now in the West Indies."

"Could you pick up cables in so large a ship as the *St. Louis?*"

"Why not? It is only a question of devoting a big and valuable craft to work which might equally well be done by a small steamer."



AMERICAN LINER IN WARTIME—BOWS ON.

"Would you like to try for those leading to Porto Rico?"

"Very much indeed."

We ran into Guadeloupe on May 11, and I immediately telegraphed to the Navy Department and to the Commander-in-Chief: "Unless I receive orders to the contrary, I shall destroy the two telegraph cables to San Juan, Porto Rico, which my first officer has laid [in] shallow, navigable waters." That evening the ship proceeded to St. Thomas, where instructions to join the admiral's flagship at the stated rendezvous off Cape Haytien, and at a stated hour were given me. Orders *not* to destroy cables never came to me because they were never sent.

We learned at St. Thomas, in ways which it is not well to divulge, that the cable from San Juan to Jamaica was out of order. To isolate Porto Rico, therefore, it would be necessary to cut the St. Thomas-San Juan line and the alternate lines leading out of Ponce to Jamaica and to St. Thomas. As time permitted, we decided to cut the first of these three lines way to the flag.

It is always surprising to find out how hard is the obtaining of any exact information on any given subject. We have all had this experience. Generalizations abound, but when one wants accurate knowledge every topic is seen to bristle with difficulties and to be shrouded in mystery. Cable-cutting is no exception to the rule. Now there are two important conditions essential to success in this operation. In the first place, you must know where the cable lies; and, in the second, how to pick it up. I think it may be broadly stated that, outside of the records of the proprietary cable company and excepting as to some shore ends, the precise location of every cable is unknown. No chart that I was able to obtain, no source of intelligence, could tell me the very spot to go for the purpose of raising the submarine wires I wished to sever. True, there are many charts indicating the presence of such lines connecting various ports, but they are all schematic only. To follow such a diagram closely in the belief that it will lead to the particular point sought would be a waste of time. There is one consideration, however, which is always useful as a guide. Cables are costly. Even the deep-sea portions, which are lighter than the shore ends, are expensive, the price running from $500 per mile upwards. It may therefore be confidently assumed that where the water is over 20 fathoms in depth and consequently quite undisturbed by heavy gales of wind, the company will follow the shortest distance between the terminal points, which, in sweeping around an irregular and salient shore, will pass, naturally, from headland to headland. For example, when wishing to pick up the Santiago-Jamaica cables, we drew on the chart the straight course connecting the harbor mouth with Holland Bay, Jamaica, where the cables land, and we were confident that what we sought would be found, if at all, not far away. As a matter of fact we got the cables just where we reasoned that they must lie. But how much more satisfactory it is to know in advance where the cable was originally placed, and how fortunate I was to have at my disposal a man who had placed it there himself and knew how to go about grappling for it.

The process of grappling is very simple in the abstract. Over the *bow*, you lower a grapnel to the bottom and then steam very slowly ahead—barely moving the ship—square across the line of the cable. The grapnel creeps over the bottom, its prongs burrow-

ing slightly under the surface of the soil until they catch underneath the cable. The gradually increasing tension on the grappling rope reveals to the expert, whose hand is always on the outboard part, that the cable is caught. The movements of the ship are under his control by signals to the bridge, and he measures the speed by the old device of the Dutchman's log—billets of wood thrown overboard from time to time. It is well to keep going ahead for a few minutes after getting an unmistakable "bite" in order to lift the cable off the bottom and thus insure its being well hooked. Then the ship is stopped, the line taken to a steam capstan or winch and hove in. As soon as the bight is well out of water a hawser is bent to it and the grapnel relieved of its duty. When the cable is inboard a stout plank to protect the deck, a couple of sharp blows with an axe, and the thing is done. Letting one end go and steaming a couple of miles away with the other, make a gap of sufficient magnitude to embarrass the repair steamer, should she come along before peace is declared.

Practically, much depends on the judgment and experience of the operator. He knows when it is best to put a shot of 3-4 in. chain just ahead of the grapnel; when best to use manila; when ordinary wire is advisable. For deep-sea work, in 1,200 fathoms or upwards, a special steel rope has been developed, very strong, very light, very flexible, its outer strands wrapped with hemp yarns. The "feel" is so much deadened that with improvised appliances you might catch and part a cable in such a depth of water and be never the wiser; or, you might miss it and think you had broken it. It is the old story—sooner or later in any particular branch of human activity we must abandon makeshifts, use standard appliances, and call in the professional.

The conditions I have just described are those most commonly found—a comparatively smooth sandy or gravelly floor. For such conditions the outfit mentioned will suffice, with patience and care.

But cables often lie on rocky bottoms; possibly they run between boulders or coral heads that protect them from the searching prong of the grapnel which engages under one rock only to spring, when freed, clean and clear over the modest retiring wire, or to have its prongs straightened out to a state of flabby uselessness. Here a cable is as safe as if buried in a trench except for the one chance out of a thousand which favors the grappler. Under these circumstances, recourse is had to one or more so-called centipedes. Imagine a piece of 5-in. or 6-in. lap-welded iron pipe, about 3 ft. or 4 ft. long. A series of square holes is cut in this pipe, each pair at opposite ends of a diameter, the diameters being placed spirally along the length of the pipe. Through each hole and its opposite, square pieces of iron or steel are driven and the ends turned forwards towards the ring by which the instrument is towed. This is a centipede. It always has for its leader a length of chain. Two or more centipedes with their leaders are occasionally bent tandem to the same line. Perseverance and repeated trials are necessary even when centipedes abound. In cable practice it is sometimes considered economical to abandon altogether a leaky wire and to replace it with a new one rather than attempt to raise and repair it in such a foul bottom.

While on this branch of the subject I may remark that the two cables from Santiago to Cienfuegos come under the head of cables protected by the nature of the bottom. We made altogether in the *St. Louis* and the *Suwanee* no less than fourteen drives for them at points varying from just outside the harbor mouth at Santiago to ten miles distant, but we never succeeded in getting the wire or in bringing up anything more than the grapnel itself with its prongs straightened out like the ribs of an inverted umbrella. The Santiago-Cienfuegos cables were our conspicuous failure.

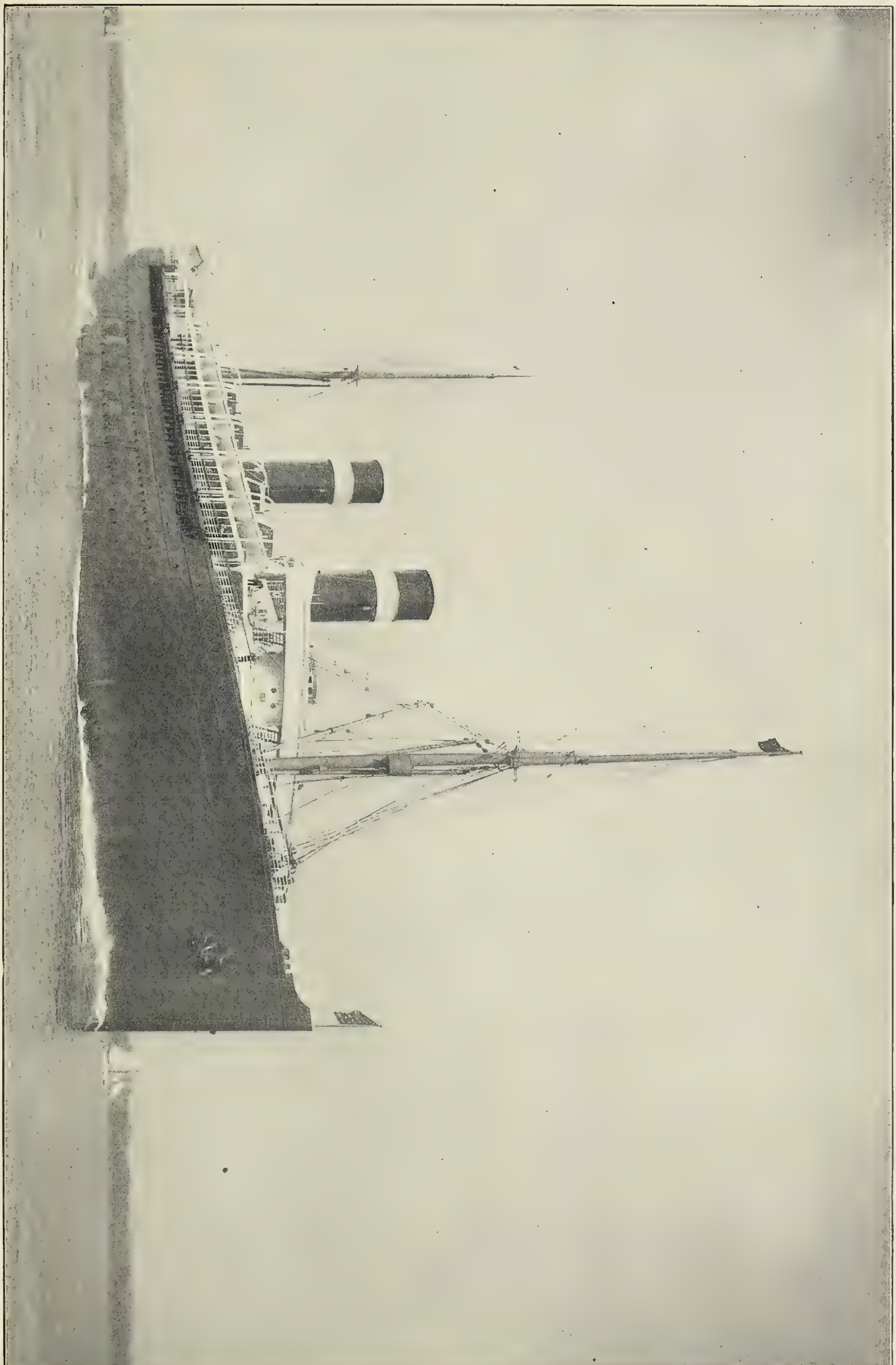
On the 13th of May the *St. Louis* broke the San Juan-St. Thomas cable. It was necessary to go quite close to the beach about eight miles east of San Juan—and great was the excitement created on shore by our approach. Horsemen could be seen riding frantically in all directions, doubtless to summon troops to resist or friends to facilitate an assumed landing on our part. Not being able to determine which was the actuating sentiment, friendship or enmity, we refrained from firing. The grapnel opened out in this drive, but it brought up enough of the gutta percha insulation and of the protecting hemp to justify us in believing that the cable was actually parted, corroborating the evidence of the heavy strain and sudden release of tension.

When, next morning early, I reported to Admiral Sampson, on board his flagship, both what I had done and what I thought I could do, he expressed his great satisfaction and he quickly adopted my suggestion that the *St. Louis* continue the work she had begun. Chief Officer Segrave was summoned over from the *St. Louis* that he might explain to the admiral his requirements in the matter of lines and grapnels. A number of manila hawsers of 6, 7, and 8 in. circumference, and a lot of stout grapnels were delivered to us by the fleet. For inshore work, where light draught and handiness were necessary, the admiral was good enough to assign to my assistance the U. S. S. *Wompatuck*, commanded by an excellent, faithful, and brave officer, Lieutenant Carl W. Jungen, U. S. Navy.

When such preparations were completed as the resources of the fleet permitted, the *St. Louis*, displacing over 17,000 tons, the largest vessel, by the way, which ever wore a pennant, and her little consort, the *Wompatuck*, of 462 tons displacement, steamed away from the flag toward Santiago de Cuba, our first point of attack on the enemy's submarine communications with Cuba.

The following day, the 15th of May, was spent in the Windward Passage, out of sight of land, in fitting up the *Wompatuck* for grappling, furnishing her with steaming water, etc. It was determined that an attempt on the Santiago-Jamaica cables should be made by that vessel May 16, and we timed our movements so as to arrive off the port about 9 P. M.

The night was appropriate to the work, being moonless, but clouds with mist and rain would have been still more acceptable as obscuring us from the enemy. Such as the weather was, however, the stars shining brilliantly in the calm air, we had no choice but to go in and run the risk of detection. Accordingly, a volunteer party from the *St. Louis*, with Chief Officer Se-



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AMERICAN LINER ST. LOUIS (STEAMING FULL SPEED AHEAD), WHICH AS THE U. S. AUXILIARY CRUISER ST. LOUIS CARRIED OUT SUCCESSFULLY CABLE-CUTTING OPERATIONS DURING THE SPANISH WAR UNDER COMMAND OF CAPT. CASPER F. GOODRICH, U. S. N.

grave at its head, went on board the *Wompatuck* with me. They were not, as yet, formally enlisted or commissioned in the United States Navy, were, in fact, only under charter to the Government by the American Line, and thus lay under no positive obligation to endanger their lives in a military enterprise.

The *Wompatuck* approached the port from the westward, hugging the land and stealing slowly toward the Morro, which soon towered above her. We were at the very mouth of the harbor. Lowering the grapnel quietly, we soon had hold of a telegraph cable, and then the heaving-in process began. In spite of our precautions some noise must have been made, for a patrol boat came out toward us. Supposing that the Morro, which was close to us, mounted guns, and believing that our presence, now known, would bring a reinforcement sufficient to deprive us of the four or five hours necessary to grapple, raise, and cut both Jamaica cables, I decided to abandon the attempt that night and try to reach my end in another way. We returned to the *St. Louis,* which lay in the offing, and learned that during our absence she had been chased by two patrol vessels flashing signals to each other. We then steamed well out of sight to the southward and westward.

On the 18th of May the *St. Louis* and *Wompatuck* came from the westward toward Santiago at daylight at the distance of a mile or so from the beach. At 5 A. M. we were within range of the batteries. The Morro fired a gun to give warning of our approach, and we supposed that it would be followed by a general opening of fire upon us. In this we were agreeably disappointed.

The water is so deep off Santiago that it was necessary to pass quite close to the batteries in order to reach bottom with our grapnel. When on a predetermined line of bearing from the lighthouse we lowered down not far from a thousand fathoms of hawser and began the slow work of feeling for the cable. It was not until after 11 A. M., if my memory serves me rightly, that the *St. Louis* hooked her fish and could heave in. In the meantime, great activity and excitement prevailed on shore. Steamboats plied between the Morro and the city bringing troops and carrying away passengers, whom we took to be women and children. At the Socapa battery and at that to the eastward of the Morro, men were working like beavers to get guns into position. It was evident that the Krupp 6-in. B. L. R.'s we had been told of as in place were not ready. Still no effort was made to disturb us, and I doubt whether, for a long time, the Spaniards suspected our object. At about noon, however, we had begun to lift the cable. Word to that effect must have been sent to the officer in command from the cable station, for the Spaniards opened on the ship—the lighthouse being then distant a mile and a tenth by observation. The shots were not well directed, however. We had no difficulty in shortly driving the gunners from their pieces near the Morro, or in seeing them as they ran away.[1] The *Wompatuck,* which had been lying well outside of the *St. Louis,* came up in great shape and joined in the action. The total broadside of the American ships in this fight was two 6-pounders on board the *St. Louis* and one 3-pounder on board the *Wompatuck.*

The battery of rifled mortars on Punta Gorda gave me much concern, for it was entirely out of reach of my little guns and yet was able to drop its shells all around us. We were practically a stationary target, for the *St. Louis* was fast to the cable. We could not make up our minds to let that go, so we stuck to it and hove it up. Once the bight was secured we could steam away as we liked. It was a great relief to me when the valuable and most vulnerable ship I commanded had put the western point of land between her and Punta Gorda. We were some forty odd minutes under fire—and exposed to large shells sent from guns beyond our range, whose accuracy of aim became painfully threatening. However, "All's well that ends well." We got the cable; we fought the Spaniards; and we silenced the guns that were within our range; and we escaped unhurt.

The next day we made an unsuccessful attempt to cut the French cable at Guantanamo, which we cut the day following, outside the Mole St. Nicholas. At this the *Wompatuck* left us to join the flag at Key West.

The rough coral bottom off the south side of Porto Rico frustrated our subsequent efforts to isolate that island and demonstrated the need of special tools.

I have spoken already of my repeated failures to get the Santiago-Cienfuegos cable by which Havana communicated with Santiago. On two of these occasions we got at night close into the beach under the Socapa battery, once in the *St. Louis,* when there were but 12 fathoms of water under her bow, which lay just outside of the surf. Why the Spaniards did not blow the big liner out of water surpasses my comprehension. She offered an ideal target, her huge bulk plainly outlined as a silhouette against the background of a searchlight beam behind her. Again, in the *Suwanee,* on June 16, I got even closer still—so close that Lieutenant Aranco, of the Spanish Navy, vainly begged the gunners to open fire on us, for he could both see and hear us distinctly. Probably Lieutenant-Commander Delehanty, who commanded the *Suwanee,* would have rejoiced in being fired at. For myself, I frankly confess I am glad the Spanish commandant rejected Aranco's proposition.

About this time the Army Signal Corps was vainly endeavoring to get the remaining Santiago-Jamaica cable—the one which it seems the *St. Louis* had left intact on May 18, although I had reason at the time to believe it broken. The corps had chartered the cable steamer *Aldria,* fully equipped for such work while I had furnished all the information in my possession, had described how and where I had grappled number one, and what measures I should take to secure number two. As far as I could I aided in every way. Among other things I had strongly advised steaming across the line of the cable from east to west, for I had towed the broken ends of number one to the westward, leaving the eastern approach clear. Any cable picked up to the eastward would, therefore, in all probability, be a live cable.

[1]In the table of bombardment of Santiago given by Commander J——, *Proceedings Naval Institute*, March, 1899, p. 29, it is stated that a 16-cm. gun at the Morro "could only fire three shots " It appeared to us on board the *St. Louis* as if the cause lay rather with the gun's crew, which certainly, to a man, sprinted in fine form.

MORRO AT ENTRANCE TO SANTIAGO HARBOR—LIGHTHOUSE TO THE RIGHT ON SLOPE OF HILL.

RAPID-FIRE GUN MOUNTED ON AMERICAN LINER (AUXILIARY CRUISER) ON THE BOAT DECK CLOSE TO THE BRIDGE.

Provided thus with all the counsel and knowledge at my disposal, the cable steamer, under the Signal Corps, made one last and dramatic effort—passing over the line with the *Oregon* and *Texas* between her and the batteries. To make a long story short, she went from *west* to *east* and she did not get the cable then or at any other time.

On the night of June 18 the admiral allowed the *St. Louis* to try for the remaining cable. Starting in after nightfall and proceeding from *east* to *west*, she picked up and severed the cable without difficulty or loss of time. From that date on no telegraphic messages passed out of Cuba via Santiago.

The *St. Louis* cut the French cable from Guantanamo to Santiago on June 7, and the same day she grappled that from Guantanamo to Mole St. Nicholas. By the admiral's orders the latter was not cut, but about 10 in. of the conductor were removed, and the injured place buoyed. The idea was to have this line only temporarily disabled and ready for subsequent use with but slight repairs. It is an interesting fact that for several hours afterward messages were sent and received over the damaged line. The moral is that if you want to stop the enemy's use of a cable you must completely sever it and separate the ends.

It was Chief Officer Segrave who put us in the way of cutting cables and who actually cut three, viz., San Juan-St. Thomas, the first Santiago-Jamaica, and the Guantanamo-Mole St. Nicholas lines. It was his temporary successor, Chief Officer George E. Beckwith, who cut the two cables which formed the loop on the Santiago-Hayti section, leading into and out of Guantanamo—a most difficult job it was, too—and also the last Santiago-Jamaica link. They both bore commissions in the navy of the United States, and well had they deserved them.

The *St. Louis* thus cut *every* foreign cable leading to Cuba and established an honorable name in connection with work which could hardly have been in the minds of her designers when they drew the plans of so noble a vessel, distinguished in war as well as in peace.

It would be unfair if I brought this brief sketch of events to a close without recording my appreciation of the loyalty and pluck of Commander Randle, previously and subsequently the worthy commodore of the American Line, who was the sailing master of the *St. Louis* during the war when not actually in command of her, and my indebtedness to his zealous and never-failing co-operation. In all this he was imitated by the officers and men who served directly under him and who speedily set up a healthy rivalry in all good things with "the regulars" on board composed of my aid, Ensign F. R. Payne, Lieutenant A. W. Catlin, U. S. M. C., and his excellent guard of marines, not to mention four naval cadets of the third class at the Naval Academy, Messrs. Fremont, Williams, Cook and Goodrich.

Marine Barracks, Navy Yard, Brooklyn, N. Y.
November 15, 1898

I certify that on August 10, 1898, I landed at the cable station at the entrance to Santiago Harbor, and had a conversation with the operator. During the conversation the operator informed me that no news had been received or sent over the Jamaica-Santiago cable since the 18th of June, the night when the *St. Louis* cut the last cable in front of Santiago.

A. W. CATLIN,
First Lieutenant, U. S. M. C.

Cambering of Steamship's Keels.

A very important decision was given in the British House of Lords, sitting as a Court of Appeals, recently, in a suit in which in the lower court Burrell & Son, shipowners, had sued Russell & Co., shipbuilders of Port Glasgow, Scotland, to recover damages for faulty construction of four cargo steamships. Judgment was delivered by the Lord Chancellor in favor of the shipowners, after a prolonged hearing which extended over eleven days.

Stripped of its legal impedimenta the cause of action was this: A contract had been made in 1893 between the parties for the construction of four steamships of large size for which the usual specifications and outline plans had been prepared. In due course the steamers were completed and accepted by the owners without complaint. About a year afterward they brought suit against the builders for $200,000, alleging that the vessels had permanent cambers or arches in their keels, which added to the risk and cost of docking them, and also that the co-efficient of fineness contracted for had been greatly exceeded. It was contended that though the contracts did not specify that the vessels were to have straight keels, it was the universal practice to so build steamships—a contract for building a house did not specify that the walls should be plumb—and the plans and models showed keels of the usual form. In response the builders had replied that the cambering of keels was not unusual; that this was done with the cognizance of the owners, and that the vessels had been accepted by the owners in full knowledge of the camber, of the draft, and of the co-efficient of fineness.

At the original hearing the Court of Sessions assoilzied the respondents (Russell & Co.), and the appeal to the court of last resort (House of Lords) was taken.

In giving judgment for Burrell & Son, the Lord Chancellor said the original contract was in writing, and no dispute had arisen as to the construction of it, and by its "express language" the plans were made part of the contract. It had not been suggested that the ships should have cambered keels when in service, though evidence had been introduced to show that in the actual process of building and in order to produce a straight keel, a small camber might be devised so as to counteract the tendency of "sagging." Speaking of one of the vessels as representing all, his Lordship said, that at the time of the contract it was the largest cargo vessel in the world, and the contract price was upwards of $800,000. It was not denied that giving this vessel a camber at all, as a steamer and not as a sailing ship, was an experiment. It was strange that so serious an experiment should not be the subject of a single sentence of the written agreement, while matters of much less consequence were referred to minutely, and the evidence showed that the attention of the owner to this serious question was called only in a casual conversation ("a few words") on a staircase.

Getting to the bottom of the matter, the Court says that a mistake had originally been made by a leading draftsman in the employ of the builders with reference to the carrying capacity, and in construction the cambering was intended to compensate for that mistake. The camber amounted to 8 in. or thereabouts. The plans had been altered subsequently by this draftsman

so as to make it appear that the vessels were not originally designed with straight keels. As to the co-efficient of fineness, evidence showed that this was .781 instead of .770, as contracted, making a difference of 120 tons to 170 tons in the carrying capacity.

Coming to the question of damages, his Lordship held that the expense of remedying the camber was not all to which the owners were entitled. It was proved that a vessel with a false keel was not as good a marketable article as a vessel without that defect. It was proved also that the contract co-efficient of fineness had been exceeded, and it was impossible to say that where skilled persons had stipulated for a particular co-efficient of fineness with reference to speed, symmetry, and economical draft of the vessel, a breach of contract in that direction could be regarded as altogether immaterial, and to be only treated as though the damages in respect of the breach were merely nominal. Taking all the heads of damage together and the cost of the efforts to remedy the structural defects they would be right in assessing the damages at $80,000. He directed the entry of judgment for this amount and all costs of litigation against the builders. Lords MacNaughten, Morris and Davey concurred.

S. S. Deutschland.—Some time this month the magnificent new liner *Deutschland*, of the Hamburg-American Line, is expected to arrive at the port of New York on her first west-bound voyage. The dimensions of the new vessel are: Length over all, 686 ft. 6 in.; beam, 67 ft.; depth, 44 ft.; net tonnage, 16,000 tons; and displacement, 23,000 tons. Her machinery equipment is of special interest in that she will be fitted with the most powerful main engines afloat. These will be twin screw of the quadruple expansion, six-cylinder type, of 33,000 collective horse power, and a sea speed of 23 knots is expected. Steam will be furnished by boilers of the Scotch type, twelve double ended and four single ended, having altogether 112 furnaces. There will be four groups of boilers, each in its own fire room, and each having uptakes connected with a separate funnel. In general design the main engines are very like those of the American liners *St. Paul* and *St. Louis*, except that the framing back and front is composed of cast steel columns of I section, with the webs cored out for lightness. The cylinders are of the following diameters: H. P. (2), 30.6 in.; first I. P., 73.6 in.; second I. P., 103.9 in.; L. P. (2), 106.3 in. dia. and all of 72.8 in. stroke. The engines are designed with the two L. P. cylinders in the center, with the two H. P. over them tandem fashion, and the first intermediate at the forward end and the second intermediate at the after end. The new vessel will be equipped in the most modern and luxurious manner, having comforts for passengers such as children's playroom, grill room, and gymnasium, in addition to those usually provided.

S. S. Cape Cod.—The new wooden hull excursion steamer for the Boston, Plymouth & Provincetown Steamboat Co., was launched from the yard of A. D. Story at Essex, Mass., May 5. The new vessel is of the single screw type with three decks, and will have accommodations for 1,200 excursionists. Her machinery will be installed by Bertlesen & Petersen, East Boston, Mass.

WAGES PAID SEAMEN OF VARIOUS NATIONALITIES AT FOREIGN PORTS.

In our last issue we presented an abstract of the reports made by United States Consuls upon the wages paid in shipyards of foreign nations. We now follow this up with a table compiled from the same United States official report on the "Merchant Marine of Foreign Countries," showing the wages paid the crews of vessels at ports of the leading maritime nations. It is hardly necessary to say at the outset that all such tables must be intelligently used; for just as with a formula, the incorrect use of such data leads to conclusions more seriously in error than had no use been made of it. There is, however, a better opportunity to make direct comparisons between the wages paid seamen of different nationalities than those paid workmen in the shipyards of different nations. For whereas in the latter case the labor of one man in one country may be equivalent to the work of two or three of another country in the same space of time, the duties to be performed in a steam vessel level down the capabilities of different nationalities to much more of an average.

There is a direct competition in carriage by sea (operation of vessels) that does not exist to anything like the same extent in vessel construction. A merchant who brings his goods to the wharf can just as readily have them loaded upon a British or German vessel as on an American vessel. Then, under normal conditions, a vessel built to carry a certain tonnage at a certain speed can complete her voyage under the designed conditions whether the crew be of one nationality or another. From the points of view of maintenance and wear and tear there are recognized differences between the seamen of different nationalities, but so there are between the crews of the vessels of any one nation, and in the broad view of vessel operation such details can be overlooked so long as questions having vastly greater bearing on the prosperity of our merchant marine remain unanswered. Taking modern steam vessels as they run, wherever built, no nation possesses any great advantage over another as to the economical operation of the machinery. The most economical forms of propelling apparatus are standard, and where any royalties have to be paid they press just as heavily on one as on another, and the form of ships is as well understood, in general, in one country as in another. It is to the personnel, therefore, that differences in the cost of operation must be attributed chiefly. This is very well displayed in the accompanying table, which shows that Americans receive substantially higher wages than seamen of other nationalities for performing similar work.

A very direct comparison can be made between our leading steamship company—the American Line—and first-class British lines leaving the same English port of Southampton. The Royal Mail is one of the old established British lines to the West Indies and South America, and the Union Line (now consolidated with the Castle Line) to South Africa is one of the leading lines connecting the mother country with an important colony. Taking the head of the list, it will be noted that the chief officer of an American liner receives $120 a month, while on the other lines the maximum is $87.50 a month. An American Line chief

engineer receives $150 a month and the British engineer a maximum of $121.75; and coming down to firemen, a class with exactly similar duties in vessels of both countries, we find the American Line paying $40 a month and the other lines paying $23 a month. Able-bodied seamen on the American Line receive $25 a month and on the British mail boats $19.50 a month.

EQUIVALENT IN AMERICAN DOLLARS OF MONTHLY WAGES PAID

Country, Port, and Nationality of Seamen.	Captain.	Chief Officer.	Second Officer.	Third Officer.	Carpenter.
[1]AUSTRALIA—					
Melbourne	......	63.26—77.86	48.66—63.26	......	43.79
AUSTRIA—					
[2]Trieste:					
Austrian	......	38.92	24.32	......	17.03
British	......	58.38	43.79	......	29.19
German	......	28.56—35.70	23.80	......	19.04—21.42
Italian	......	43.75	30.62	......	11.38—14.00
BELGIUM—					
Antwerp:					
Société Anonyme Belge du Congo	......	62.72	38.60	28.95	28.95
Tank Steamers	......	28.25	33.77	24.12	24.12
Red Star Line	......	62.72—72.37	53.07—57.90	43.42—28.25	28.95
CANADA—					
Montreal	......	58.39—77.86	34.06—41.35	......	29.19—31.62
New Brunswick	......	30.00—35.00	20.00—25.00	......	......
[3]Nova Scotia	......	25.00—45.00	20.00—30.00	......	30.00—35.00
CHILE—					
[4]Valparaiso	......	41.50	33.00	26.40	......
DENMARK—					
Copenhagen	......	29.48	20.10	......	18.22
[5]FRANCE—					
Havre:					
French	......	57.90—67.55	38.60—48.25	......	17.37
British	......	29.20—38.93	24.33—29.20	......	19.47—24.33
German	......	......	......	......	......
Italian	......	38.60	28.95	......	17.37
Scandinavian	......	20.10	16.08	......	17.42
Marseilles:					
French:					
Compagnie Générale Transatlantique	96.50	48.25	......	......	21.23
Compagnie des Messageries Maritime	96.50	38.60	......	......	14.47
Cyp. Fabre Compagnie	77.20	38.60	......	......	15.44
British	......	38.93—53.53	29.19—38.93	......	30.40
German	......	35.70	23.80	23.80	19.04
Scandinavian	......	......	......	......	12.15
GERMANY—					
Bremen	......	......	......	......	15.50—19.00
[6]Hamburg	......	29.75	21.42	......	17.34
Lower Baltic	......	23.80	17.85	......	19.04
[7]ITALY—					
Foreign Trade	70.00	40.00—50.00	40.00	......	16.00—18.00
JAPAN—					
Yokohama:					
Japanese	......	25.00—35.00	15.00—22.50	......	......
American	......	50.00—90.00	40.00—60.00	......	40.00—45.00
British	......	58.40	48.67	......	......
German	......	40.00—75.00	33.75—40.00	......	......
NETHERLANDS—					
Amsterdam:					
East India Passenger	......	60.00—80.00	36.00—40.00	24.00—28.00	24.0
East India Freight	......	57.60	48.00	25.50—33.60	25.20
Holland America	......	40.00	28.00	16.00—20.00	24.00
[8]Tank Steamers	......	57.60	38.40	24.00	24.00
British	......	43.80	34.06	24.33	......
Norwegian	......	50.92	40.20	......	......
NEW ZEALAND—					
All Ports	......	68.13	58.40	......	48.66
UNITED KINGDOM—					
[9]Liverpool:					
British	......	55.61	40.83	33.52	31.50
French	......	48.25	48.25	......	15.44
German	......	......	......	......	......
Scandinavian	......	19.46—34.06	14.59—24.33	......	21.89—26.76
Spanish	......	43.79	34.06	......	19.46
Southampton:					
American Line	......	120.00	70.00	70.00	......
Royal Mail to South America	......	73.00—82.75	43.75—48.75	31.75—39.00	......
Union Line to Cape	......	68.25—87.50	48.75—58.50	31.75—39.00	......
[10]Glasgow:					
Allan, Anchor, and Donaldson Lines	97.33—121.66	60.82—72.99	48.66—60.82	36.49—48.66	......

[1]Wages given are for coasting vessels. Few, if any, deep-water steamships are owned in the colony. Vessels of other nationalities pay the current rate of wages. [2]Seamen of nationalities other than those given are usually paid Austrian wages when hired.
[3]These wages are paid in the foreign trade irrespective of nationality or ship. [4]Wages scheduled are in American gold equivalents.
[5]French law requires that owners of vessels shall feed their men as well as those serving on war vessels—this figures out about 30 to 40 cents per day for each French merchant sailer. [6]Sailors must submit to a physical examination by government surgeons before being granted a permit to ship on German merchant vessels.

Turning now from the Atlantic to the Pacific, very similar conditions are found. The United States Consul at Yokohama reported the average wages paid on American, British, Japanese, and German ships at that port. By reference to the accompanying table the differences can easily be secured. Mates on American vessels receive a maximum of $90 a month, British $58.40; Japanese, $35, and German, $75. Again, Ameri-

SEAMEN OF VARIOUS RATINGS AND NATIONALITIES AT FOREIGN PORTS.

Boatswain.........	Quartermaster......	Able Seaman.........	Chief Engineer......	Second Engineer....	Third Engineer.....	Fourth Engineer....	Oilers...............	Firemen	Coal Trimmers......
34.06	30.62	29.19	97.33—121.66	77.86—87.59	68.13—72.99	....	38.93	38.93	29.49
17.03	14.00	12.16	58.38—77.84	34.06—48.65	19.46—29.19	....	14.60	15.82	12.16
29.19	25.55	24.33	58.38—68.11	46.22	27.36	....	25.00—26.00	26.76	24.00—25.00
19.04—21.42	19.04	11.90—16.66	59.50	28.56	23.80	....	13.00—17.00	14.28—19.04	12.00—15.00
11.38—14.00	10.00—13.00	9.63	61.25	45.98	30.62	....	12.00	12.25	11.38
....	....	17.37	77.20	57.90	43.42	36.19	....	19.30	16.40—16.79
24.12	....	19.30	77.20	57.90	43.42	33.77	23.16	21.62	16.40
28.95	....	19.30	96.50—115.80	69.96—72.37	55.49—57.90	52.66—53.07	23.60	21.71	16 89
24.33—26.76	....	19.46—21.89	82.73—102.19	63.26—82.73	43.79—58.39	....	19.46—24.33	19.46—24.33	14.59—21.89
22.00—25.00	....	18.00—20.00	75.00—100.00	60.00	45.00	....	30.00	25.00—30.00	20.00
20.00—25.00	22.00—25.00	18.00—20.00	90.00—100.00	60.00—65.00	40.00—45.00	....	28.00	25.00	20.00—22.00
16.50	11.50	10.00	82.50	49.50	33.00	....	14.85	11.50	8.25
17.42	....	16.08	53.60 93.80	32.16—53.60	26.80	....	....	16.08	16.08
23.16	....	12.55	77.20—86.85	48.25—67.55	28.95—38.60	....	19.30—23.16	15.44—19.30	11.58—13.51
17.03—21.90	19.47	14.60	77.86—97.33	48.67—73.00	34.06—38.93	....	15.81—19.27	21.90—24.33	18.25—19.47
....	....	13.09	....	....	15.23	....	....	16.66	11.90
19.30	....	12.55	77.20	48.25	....	....	9.65	19.30	10.62
17.42	....	13.40	58.96	32.16	....	....	....	14.74	13.40
24.12	....	14.47	67.55	38.60	38.60	....	....	16.40—19.30	13.51
17.37	....	14.47	57.90	28.95	....	....	....	17.37—18.33	14.47
21.23	....	13.51	77.20	38.60	28.95	....	....	16.40—21.23	....
20.67	....	15.80—17.02	63.26—68.13	48.66	31.62—38.93	....	....	17.02—18.24	14.59
17.85	....	14.28—16.66	89.25	52.36	33.32	....	....	16.66	....
13.89	....	11.96	....	....	....	....	....	13.51	8.68
....	....	10.71—11.90	65.00—101.19	43 00—71.90	25.00—47.62	....	....	11.90—14.28	11.55—14.55
15.71	17.85	13.33	59.50—71.40	35.70—42.84	23.80—33.82	....	14.28—15.47	14.28—15.47	14.28—15.47
16.66	....	13.09	42.84	23.80	20.23	....	....	13.09	....
16.00—18.00	12.00	....	70.00	50.00	30.00	30.00	18.00	16.00—17 00	12.00
9.00—10.00	7.00— 7.50	5.50	50.00—60.00	30.00—40.00	....	....	....	5.50	....
18.00—20.00	20.00—30.00	14.00—30.00	150.00	70.00—90.00	....	....	....	14.00—20.00	....
26.76	....	14.60	....	....	....	....	....	17.00—20.00	....
15.50—18.75	14.75—13.00	14.25—15.00	62.50—100.00	53.75—62.50	....	....	....	15.50—20.00	....
22.00	15.20—16.00	12.00	80.00—120.00	54.00—68.00	36 00—40.00	24.00—28.00	16.00	15.20—16.00	10.00
23.20	15.20	14.00	86.40—96.00	52.00—62.40	28.00—40.00	24.00—28.00	....	16.00	13.20
24.00	16.00	14 20	64.00—88.00	40.00—44.00	28.00	16.00	16.80	16 00	12.00
19.20	....	14.40	96.00	57.60	48.00	28.80	....	16.00	....
24.33	....	17.03	87.60	58.40	38.93	29.20	....	18.24	....
....	....	14.74	67.00	48.24	40.20	....	....	14.74	....
36.50	31.63	31.63	97.33—121.66	77.86—87.60	58.40—70.56	....	41.37	41.37	31.63
25.48	19.46	18.03	87.11	62.10	45.14	....	....	20.31	17 73
19.30	....	11.58	77.20	48.25	33.77	....	19.30	17.37	13.51
....	....	....	48.66—72.99	36.48—48.66	29.19—36.48	....	9.73 - 12.16	12.16—14.59	9.73—14.59
19.46—26.76	....	14.59—17.14	58.39—97.33	38.93—58.39	29.19—43.79	....	....	14.59—15.80	13.38—14.59
19.46	....	16.52	77.86	58.39	48.66	....	18.48	13.62—17.51	....
....	....	25.00	150.00	100.00	85.00	65.00	....	40.00	30.00
....	....	19.50	121.75	77.75—87.50	58.50+	48.75+	....	23.00	18.25—23.00
....	....	19.50	97.25—121.75	63.25—77.75	48.75—58.50	48.75	....	23.00	18.25—23.00
24.33	23.11	19.46	87.59—116.79	58.39—87.95	38.93—58.39	....	19.46	20 68—21.28	19.46

[7]U. S. Consul at Naples says: "Wages on Italian merchant vessels vary largely, there being no uniform rate. A separate and private bargain is made with each man, secrecy as to what is paid being enjoined" [8]These vessels vary in size from 1,734 to 4,157 gross tons. [9]Cunard and White Star Lines pay higher wages. [10]Regular lines in the East India trade employ Lascar seamen, who receive not more than $4 per month. Captains and deck officers are paid about the same rates as on the Atlantic, and engine and fire-room staffs receive 5 % less. On ocean tramps wages are usually from 7½% to 10% less on all ratings as compared with regular lines.

can chief engineers receive $150 a month; Japanese, $60, and German, $100. American and European firemen get a maximum of $20, while the Japanese pay for the same work is $5.50 a month.

In addition to wages, the cost of maintenance is, of course, a considerable part of the expenses of operation, especially on long voyages. Unfortunately, none of the queries addressed to United States Consuls by the Department of State covered this point, so that the information on the subject in the published reports is confined to a very few statements, made voluntarily. The United States Consul at Havre, France, as the result of an unofficial investigation at that port, reports the cost of maintenance for each man to be as follows: Norwegian and Swedish vessels, 25 cents a day; German vessels, 36 cents; English vessels, 25 to 35 cents; Italian vessels, 22 cents, and French merchant vessels, from 30 to 40 cents a day. At Marseilles, France, the United States Consul made inquiries among the consular officers of other nations, and as a result reports average allowances as follows: For British officers $1.21 and crew 36 cents a day; Italian officers 30 cents and crew 19 cents; Norwegian and Swedish officers and crew 41 cents; Austria-Hungary, for officers 38 cents and crew 30 cents a day.

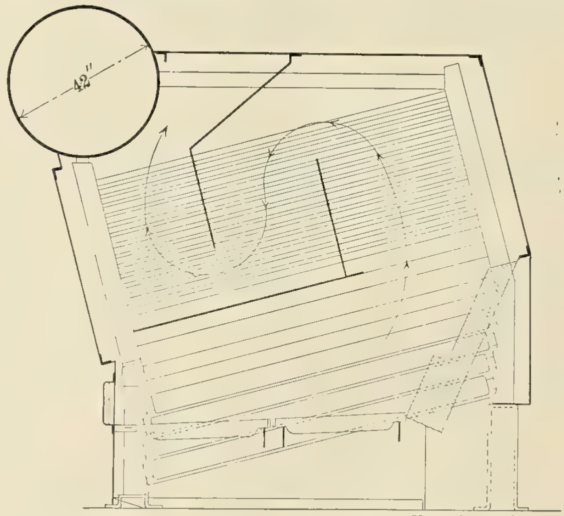
Many who have not studied the question have an opinion that it is only in this country that the merchant marine is the subject of discussion and agitation, and that there is something novel about the proposition of government aid as well as control. For those who seek information which will quickly dispel such ideas a perusal of the publication here quoted from is recommended. Not only are those maritime nations which are lacking in proper shipping facilities widely awake to the need for energetic action, but even the British are alive to the importance of maintaining their position on the seas. Causes such as operate to keep our flag off the seas—so long as Congress is content to let it remain on land—are recognized as being, in many instances, detrimental to British interests, and if so to theirs, how much more so to ours?

Wreck of S. S. Carinthia.—One of the Cunard Line freight steamships, the *Carinthia*, on the Boston route, was recently chartered by the British Government to take 1,450 mules from New Orleans to Cape Town, and while on the voyage out went ashore at Point Gravois, Haiti, May 15. A steamer which went to her assistance reports that the *Carinthia* is fast ashore, and her forehold is full of water. Many of the mules were landed in safety, but several hundred are reported to have been lost. A wrecking steamer has been ordered to the scene. This vessel, and her sister ship, the *Sylvania*, came out about 1895, and attracted much attention on account of their economical performances. The dimensions of the *Carinthia* are: Length, 460 ft.; beam, 49 ft.; depth, 42 ft. 6 in.; dead weight capacity, 7,500 tons; displacement, 12,160 tons. She is fitted with twin screw main engines of about 5,000 I. H. P., with cylinder 22 1-2 in., 36 1-2 in. and 60 in. dia., and 48 in. stroke. The boilers are of the Scotch type, worked with Howden draft. The sea speed is about 15 knots. The mishap is reported to have been caused by an error in the chart.

PROTECTED CRUISERS OF THE DENVER CLASS FOR THE U. S. NAVY.

Unlike merchant vessels, designs for warships have always been regarded as tentative, governed by a judicious compromise of weights allotted to the following: Hull proper; machinery, which gives speed; armor, armament and ammunition; coal carrying capacity, or endurance to keep the sea. Naval experts have, at all times, differed as to the relative importance of these, both for cruisers and battleships; moreover, the problem changes from time to time to conform to the progressive improvements in materials. It happens, therefore, that a wise distribution of weights for any class of war vessels to-day may not be so regarded a few years hence.

In contracting for six vessels of the *Denver* class, the Navy Department has made a marked departure from recent practice in one notable particular—speed—the machinery weights apportioned being only sufficient to provide a maximum speed of 16 1-2 knots at full power.

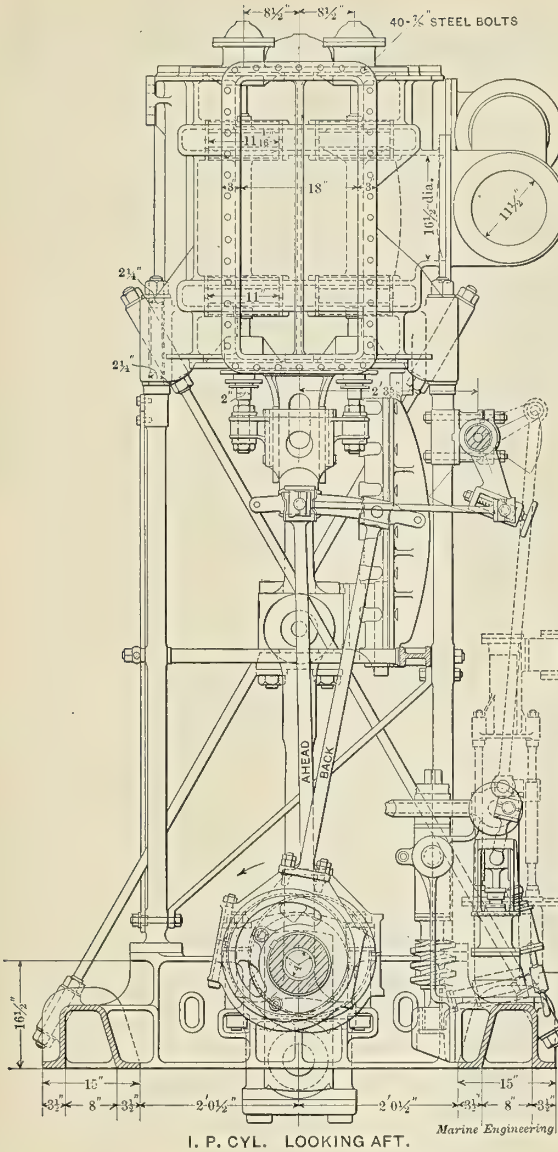


B. & W. BOILER SHOWING PATH OF GASES (SEE PAGE 246).

An important feature of design centers in the liberal coal bunker capacity allotted—700 tons when fully stowed—and the consequent extended steaming radius at economical speed. At about 10 knots these vessels will be able to cover about 6,300 knots without recoaling, and in the neighborhood of 2,300 knots at full power.

Another unusual characteristic, not heretofore embodied in warship designs in this country to any extent, consists in wood-sheathing and coppering the steel outside plating to slightly above the load water line. Although this involves considerable extra weight, the immunity of the coppered bottom from a tendency to foul, compared with steel, furnishes a substantial reason for the adoption of the proposed plan in the consequent maintenance of speed and saving of fuel, in addition to decreased cost due to frequent docking. The wood-sheathing is to be of Georgia pine, fitted in a single thickness of 4 in., and secured to the plating by composition bolts.

[1]See Marine Engineering, Vol. IV, pages 1 and 260, and Vol V, page 157.



I. P. CYL. LOOKING AFT.

SCALE OF FEET

END ELEVATION MAIN ENGINES—DENVER CLASS.

In previous issues[1] we have presented an account of the principal characteristics of these cruisers and also a concise report of the contents of a paper by Chief Constructor Philip Hichborn, U. S. N., on the designs of the *Denver* class, read at the 1899 meeting of the Society of Naval Architects and Marine Engineers, together with the discussion evoked. We now supplement this with technical details of the construction of the hull and machinery, together with drawings to scale:

Length over all	308.75 ft
Length on load water-line	292 "
Beam, moulded	43 ft 3¼ in.
Beam, extreme	44 ft.
Area of midship section	615 2 sq ft.
" " load water plane	9,370 " "
Mean draft (with 467 tons of coal and ⅔ stores)	15 ft 9 in.
Corresponding (trial) displacement	3,200 tons.

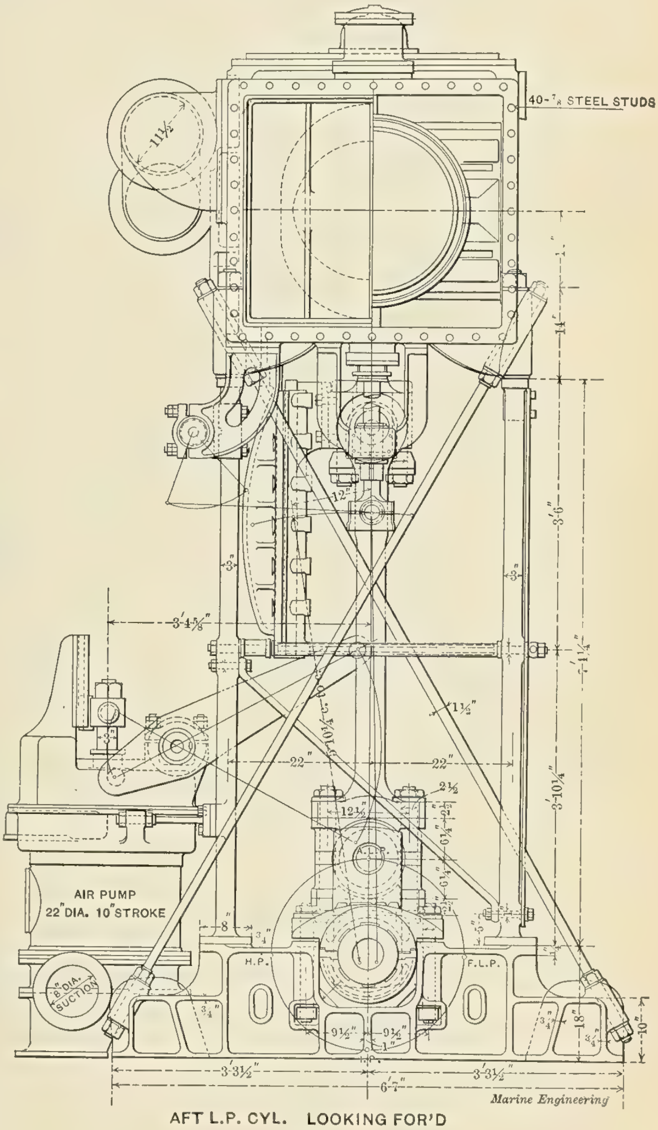
GENERAL DESCRIPTION OF THE HULL.

The stem is made in two pieces, the lower part of cast manganese bronze and the upper of rolled bar iron 9 in. by 4 in.; the stern post is of manganese bronze. Frames are spaced 36 in. from center to center, and composed of steel Z-bars, 6 in. by 3 1-4 in. by 3 1-2 in., weighing 15.6 lb. per running ft.

The outside plating is generally of 15 lb. plate (3-8 in. thick) per sq. ft., as are also the inner flat and vertical keel plates; the outer flat keel is of 20 lb. plate.

Three longitudinals are worked on each side of the vertical 34 in. keel; the first and second are of 12 1-2 lb. plates, and extend about 190 ft. in length of the vessel; the remaining longitudinal, which forms the outer marginal plate on each side of the double bottom, is about 135 ft. in length and composed of 15 lb. plate.

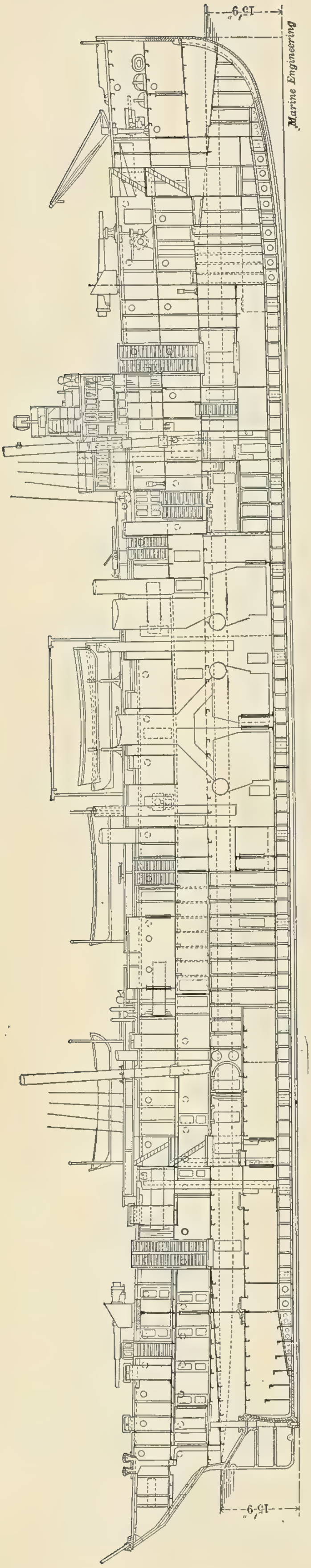
Three complete steel decks are fitted, the beams being of angle bulb section, 7 in. by 3 in., of 18 1-4 lb. per lineal ft., and the deck plates varying in weight between 10 and 20 lb. per sq. ft. The protective deck is 1-2 in. thick throughout, and in addition 2 in. of nickel steel plate, 8 ft. in width, is fitted on each slope for a length



AFT L.P. CYL. LOOKING FOR'D

SCALE OF FEET

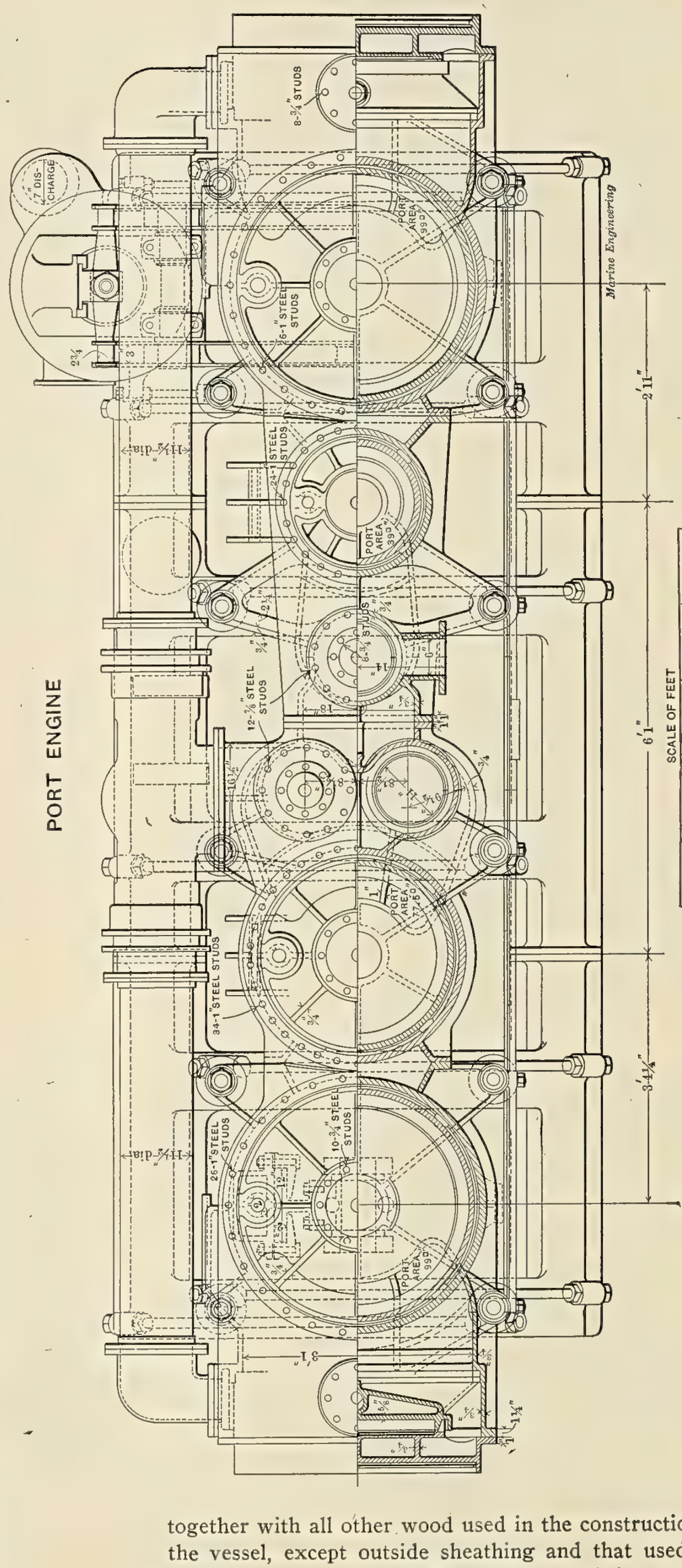
END ELEVATION MAIN ENGINES—DENVER CLASS.



INBOARD PROFILE OF DENVER CLASS OF TWIN SCREW, SHEATHED, PROTECTED CRUISERS NOW BUILDING FOR THE. U. S NAVY—DESIGNED BY NAVAL BUREAU OF CONSTRUCTION AND REPAIR.

of 105 ft. in the wake of the machinery; forward and abaft of this the 1-2 in. plating is of double thickness.

Only the main deck is planked with wood, and this,

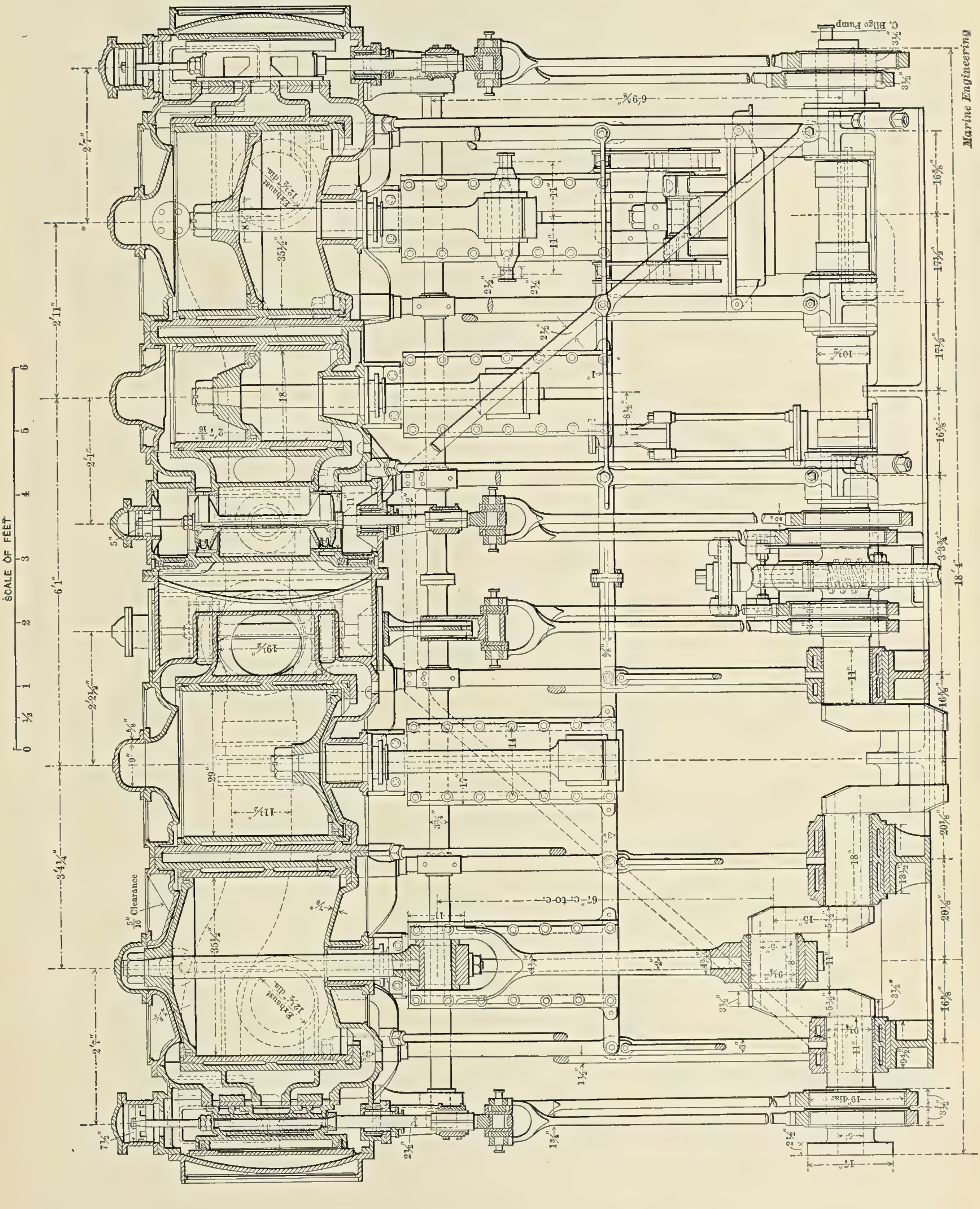


PLAN VIEW OF TRIPLE EXPANSION MAIN ENGINES OF U. S. DENVER CLASS OF PROTECTED CRUISERS.

together with all other wood used in the construction of the vessel, except outside sheathing and that used for special purposes, is to be fireproof before being worked

into the vessel. The use of wood is reduced to a minimum, corrugated metal being substituted where feasible.

Immediately above the protective deck, and extending

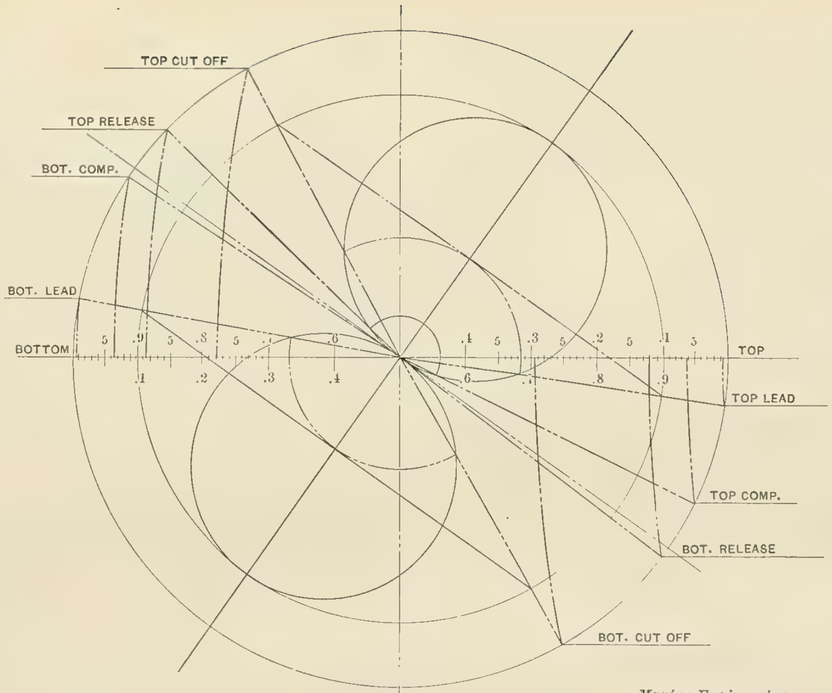


SECTIONAL ELEVATION OF TRIPLE EXPANSION MAIN ENGINES OF DENVER CLASS OF PROTECTED CRUISERS—DESIGNED BY U. S. NAVAL BUREAU OF STEAM ENGINEERING.

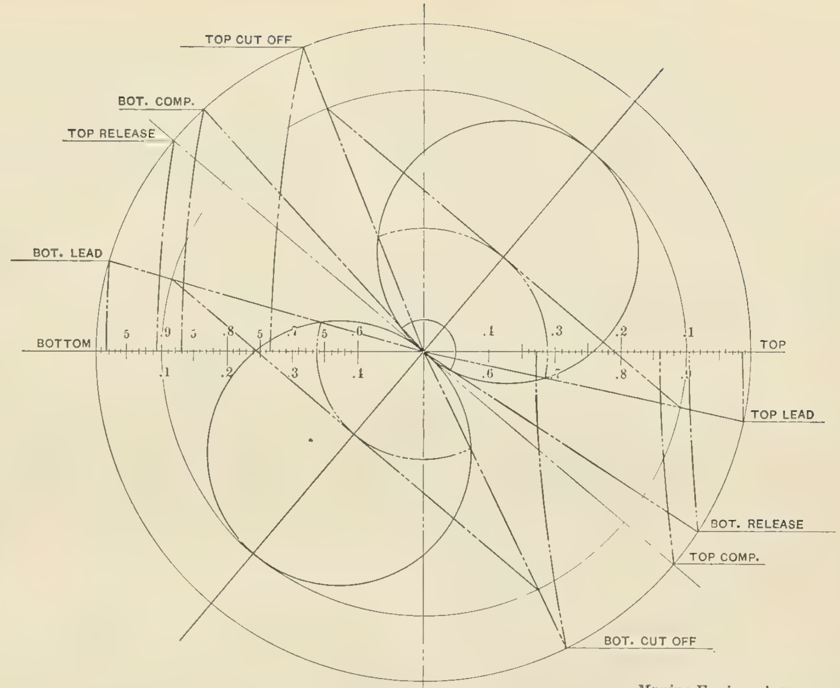
above and below the normal water line, a cofferdam, 4 ft. in height and 27 in. in width, is provided. This is to be filled with fire-proof corn pith compressed cellulose to prevent the ingress of water in case of a chance shot through the outside plating.

ARMAMENT.

The main battery consists of ten 5-in. rapid fire guns, 50 calibres in length. One of these is to be mounted forward and another aft on the amidship line on the



H. P. & I. P.



L. P.

VALVE DIAGRAMS FOR TRIPLE EXPANSION MAIN ENGINES OF DENVER CLASS OF PROTECTED CRUISERS, DRAWN BY THE NAVAL BUREAU OF STEAM ENGINEERING.

main deck, and four on each side of the gun deck below. The secondary battery consists of the following: Eight 6-pound rapid fire guns; two 1-pounders; four machine guns, and one field gun. A full allowance of ammunition, for which provision is made in the magazines, weighs about 343,000 lb.

MACHINERY.

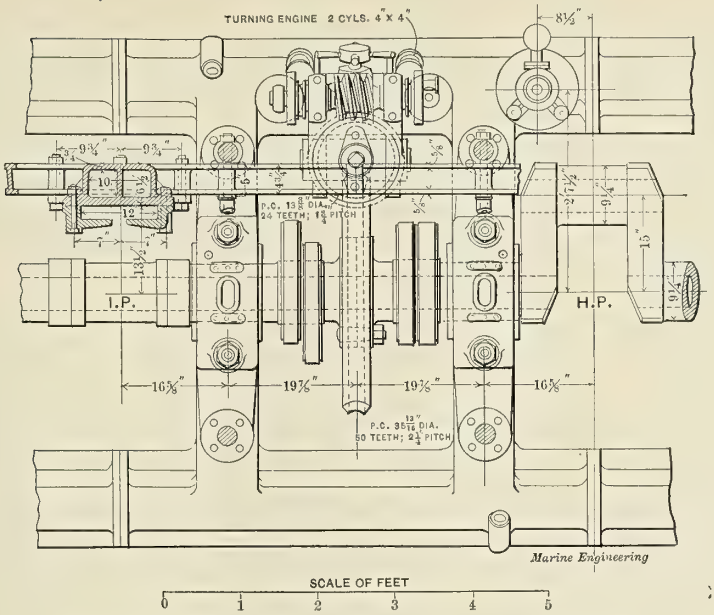
Designs for the machinery were prepared in the Bureau of Steam Engineering, Navy Department, under the supervision of Engineer-in-Chief George W. Melville.

The propelling engines, which drive twin screws, are placed in water-tight compartments, separated by a middle-line bulkhead. Each is of the vertical, inverted-cylinder, direct-acting triple expansion type, with a high pressure cylinder of 18 in., intermediate of 29 in., and two low pressure cylinders of 35 1-2 in. dia. The stroke of all pistons is 30 in., and the collective indicated horse-power of the main propelling and circulating-pump engines is calculated to be 4,500 when developing full power. Under these circumstances the main engines are expected to make about 172 revolutions per minute with a steam pressure in the boilers of 275 lb. reduced to 250 lb. at the high pressure cylinders.

Beginning forward, the arrangement of cylinders is: forward low pressure, high pressure, intermediate, and after low pressure. The cranks of the forward low pressure and high pressure are opposite, as are also the cranks of the intermediate and after low pressure.

All main valves are worked by Stephenson double-bar links, the various parts of which for the four cylinders, so far as practical, are made interchangeable. Each high pressure cylinder is provided with one, and each intermediate cylinder with two piston valves, all of the same dimensions; double ported balance slide valves are fitted to the low pressure cylinders, and all main valves are provided with a balance auxiliary piston.

The reversing gear for each engine consists of a steam cylinder and a hydraulic controlling cylinder, acting directly on two arms fixed to the reversing



DETAILS OF CROSS HEAD SLIDES, CRANKS AND TURNING GEAR.

shaft. By a system of differential levers motion of the steam engine reversing valve—primarily derived from the hand lever on the working platform—causes the reversing engine to follow, or to come to rest, accordingly as the hand lever is moved or stopped.

The framing for each engine consists of six front and

Name of Vessel.	Cruisers Nos. 14 to 19. "Denver" Class.					
Total I.H.P. and Displacement.	4500 I.H.P 3200 Tons Displacement.					
Type and number of Engines.	4 Cyl. Vertical Inverted Triple Engine Twin Screw.					
Diams. of Cylinders and Stroke.	18", 29", 35½", 35½" x 30" Stroke.					
Valve Gear.	Stephenson Link.					
Connecting Rod.	67" between centers.					
SCALE OF CRANK CIRCLE 4"=1 FT.	SCALE OF VALVE CIRCLES 24"=1 FT.					
	H.P.		I.P.		L.P.	
Eccentricity.	2"		2"		2"	
Travel of Valve.	4"		4"		4"	
Kind and No. Valves and Diam. if Piston Valves.	One Piston 11" Dia.		Two Piston 11" Dia.		One Double Ported slide	
Side of Valve on which Steam is taken.	Inside.		Outside.		Outside.	
	Top	Bottom	Top	Bottom	Top	Bottom
Width of Port and Length if Slide Valve.	1½	1½	1½	1½	1½ x 37	1½ x 37
Steam Lap.	29/32	27/32	29/32	27/32	15/16	13/16
Exhaust Lap.	−5/16	−1/16	−5/16	−1/16	0	+¼
Angular advance.	35°	35°	35°	35°	40°	40°
Steam Lead. Angular.	8°	10°	8°	10°	12°	16°
Steam Lead. Linear.	¼	5/16	¼	5/16	11/32	15/32
Cut off in inches.	23⅜	21 3/16	23⅜	21 3/16	22 [illegible]/16	20 3/16
Cut off in decimal of stroke.	.78	.705	.78	.705	.735	.672
Exhaust Release in inches.	3 7/16	3⅝	3 7/16	3⅝	2 13/16	2⅞
Exhaust Release in decimal.	.114	.1205	.114	.1205	.093	.095
Compression in inches.	1⅞	1 15/16	1⅞	1 15/16	4 3/16	3⅞
Compression in decimal of stroke.	.062	.064	.062	.064	.139	.129
Steam opening.	1 3/32	1 5/32	1 3/32	1 5/32	1 1/16 x 2	1 3/16 x 2
Exhaust opening.	Full Port		Full Port		Full Port	
Velocity of Steam in ft. p. sec. @ 860 ft. per. min. 172 Revs. per. min.	128.6	121.6	166.9	157.9	189.3	169.4
Velocity of Exhaust in ft. p. sec. @ 860 ft. per. min. 172 Revs. per. min.	93.82	93.82	121.7	121.7	134.12	134.12
Velocity of Exhaust to Condenser.	115.6 ft. per sec. 12½" Nozzle.					

DATA TO ACCOMPANY VALVE DIAGRAMS ON OPPOSITE PAGE.

six back forged steel columns, 3 in. dia., trussed by forged steel stays, and the bed plates are of cast steel, supported on the keelson plates.

All shafting is hollow, and forged from nickel steel, made by the open hearth process; piston and connecting rods, and working parts generally, are also of the same material. Tensile specimens of shafting must have at least an ultimate strength of 80,000 lb. per sq. in. of section, and an elongation of 25 per cent in 2 in. Forgings for piston and connecting rods must show a tensile strength of 95,000 lb. and an elongation of 21 per cent in 2 in.

Each main engine is provided with a cylindrical condenser 4 ft. 4 1-2 in. inside dia., and 11 ft. long over all. The shell is 1-4 in. plate steel, and the water chest at each end is of cast composition 1-2 in. thick. In each condenser there are 2,004 seamless drawn tubes 5-8 in. outside diameter, No. 18 B. W. G. thick, 9 ft. 2 in. long between tube sheets, and which provide 3,000 ft. of cooling surface measured on the outside of the tubes.

There is, for each engine, one vertical single-acting air pump, worked by link and beam connections from the forward low pressure crosshead. The pump cylinder is 22 in. dia., with a stroke of 10 in.

A centrifugal circulating pump, driven by a two cylinder engine is installed for each condenser. These pumps are of the double-inlet pattern and so arranged by valves to draw either from overboard or the bilge; when connected to the latter, each pump is capable of discharging 5,000 gal. of water per min., running at a speed not to exceed 300 revolutions.

The screw propellers are entirely of manganese bronze, with blades cast separately and bolted to a boss. Before being fitted to its shaft, each propeller is to be accurately balanced, tinned all over and burnished. The starboard propeller is left and the port right handed.

The usual auxiliary machinery, common to all war vessels, is to be installed. In addition to the various pumps, steering and anchor engines, blowers, etc., provision is made for electric lighting, ice, and distilling plants. The exhaust steam from these is utilized as an agent to elevate the feed water temperature by means of a heater placed in each engine room.

Steam is to be supplied by six boilers of the water tube type, located in two water-tight compartments forward of the engine rooms. The working pressure is 275 lb. per sq. in., and the minimum total grate and heating surface for all boilers is 300 and 13,000 sq. ft. respectively. Two boilers are placed in the after and four in the forward compartment, with a smoke pipe 70 ft. in height above the grates for each nest of boilers. The clear cross sectional area of each smoke pipe is one-seventh the grate area of the boilers, to which it connects. One athwartship fireroom is provided for the boilers in each compartment.

The type of boiler selected for three of the vessels of this class—the *Chattanooga, Galveston,* and *Tacoma*—is the well known Babcock & Wilcox design, a description of which appeared in our issue for March last. Boilers for these vessels differ in some slight particulars from that described, but principally in the method adopted of directing the flow of the gases of combustion, which is done by means of baffles, as indicated by arrows in the accompanying engraving. (See page 240.)

A summary of the trial displacement weights is as follows:

SCHEDULE OF WEIGHTS.

Hull and fittings, not including protective deck armor	1,706 tons.
Protective deck armor, 2 in	62 "
Cellulose	24 "
Armament and ammunition	213 "
Equipment, stores, and outfit	287 "
Propelling machinery with water	441 "
Coal	467 "
Total	3,200 "

The successful bidders and contract price for each ship is shown in the table which follows:

Name of Vessel.	Contractors.	Location of Works.	Contract Price.
Denver	Neafie & Levy Ship & Engine Building Co.	Philadelphia, Pa.	$1,080,000
Des Moines	Fore River Engine Co.	Weymouth, Mass.	1,065,000
Chattanooga	Lewis Nixon.	Elizabethport, N. J.	1,039,966
Galveston	Wm. R. Trigg Co.	Richmond, Va.	1,027,000
Tacoma	Union Iron Works.	San Francisco, Cal.	1,041,900
Cleveland	Bath Iron Works.	Bath, Me.	1,041,650

According to the terms of the contract, all these vessels are to be ready for delivery to the Government on or before June 14, 1902.

Relief Ship for India's Starving.

In this land of plenty it is practically impossible to realize what the word "famine" means. It is at present understood, however, in all its horrible reality by millions of starving inhabitants of British India. To aid in the alleviation of this suffering, persons of all denominations in the United States and Canada, who are readers of the *Christian Herald,* have contributed 200,000 bushels of corn, which are now en-route to Bombay on the S. S. *Quito.*

When the corn had been collected application was made to the United States Government for the services of a vessel to carry it from the port of New York to India. Under the provisions of an existing law authority was given to charter a vessel for the purpose. Lieutenant-Commander Nickels, U. S. N., was directed to select a suitable vessel, and his choice fell on the S. S. *Quito.* It is a sad commentary on the condition of our merchant marine that the vessel sent on this errand of mercy flies a foreign flag. She was undoubtedly the most suitable vessel to be had, and being a comparatively new and a staunch ship, she is expected to arrive out about June 20, with her cargo in prime condition.

The work of loading the vessel was commenced at the Brooklyn, N. Y., water front on Monday, May 7. The cargo was delivered to the vessel by floating elevators, in bulk, and was sacked before being stowed. A snapshot on the deck of the *Quito* when loading is here reproduced. By the following Wednesday evening the vessel was loaded and ready for sea, and she sailed May 10. Special religious services were held on board before her departure. On the trip out brief stops will be made at the Azores, Port Said and Aden, for coal.

Dr. Louis Klopsch and the Rev. E. S. Hume are the consignees, and they have already reached Bombay and arranged for the unloading and distribution of the

RELIEF STEAMER S. S. QUITO AT WHARF—PHOTO BY COURTESY OF AND COPYRIGHT, 1900, BY BROOKLYN EAGLE.

corn. In the latter work they will be assisted by an Interdenominational Missionary Committee, which is composed of American missionaries, with Dr. Robinson, of the Methodist Church at Calcutta, as chairman.

It is authoritatively stated that this is the largest cargo ever carried by any vessel on a like errand. The

SACKING GRAIN FROM ELEVATOR SPOUTS ON DECK OF S. S. QUITO, AT BROOKLYN, N. Y.

200,000 bushels of choice two-year-old corn are valued at over $100,000, and at the famine prices in India are worth not less than $300,000. The charter price paid by the United States Government was $40,000.

The S. S. *Quito*, Captain Baird, was built last year at Port Glasgow and flies the British flag. Her dimensions are: Length, 330 ft.; beam, 45 ft. 6 in.; depth, 26 ft. 6 in.; gross tonnage, 3,200 tons. She is fitted with triple expansion engines, built by Dunsmuir & Jackson, Glasgow, with cylinders 24 in., 40 in., and 65 in. by 43 in. stroke. She is classed 100 A1 at Lloyd's.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—III.

BY CECIL H. PEABODY.

The Coffin averaging instrument shown by Fig. 14 is a planimeter which has one end of the tracing-arm guided by a straight groove, and which has its measuring-wheel set to one side, with its axis parallel to the tracing-arm. A movement of the tracing-arm parallel to itself will describe a parallelogram like Fig. 7, and its area will be properly measured by the wheel; the instrument is always used in the first method (as in measuring indicator diagrams); consequently the effect of

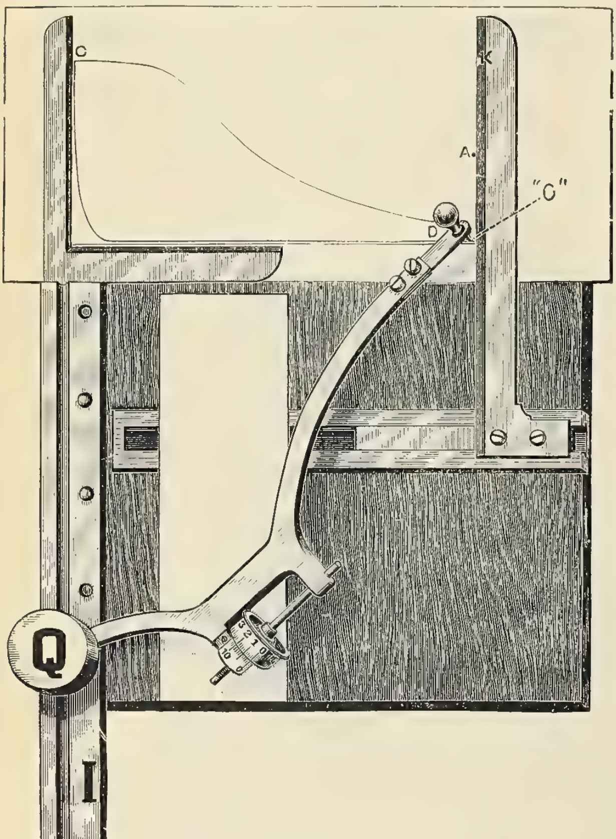


FIG. 14.

the swinging of the arm back and forth is finally zero, whether the axis of the wheel coincides with the arm or is parallel to it. The arm is 6 in. long, and the wheel has a circumference of 2 1-2 in., consequently one turn of the wheel is equivalent to 15 sq. in.; the scale of the wheel is divided into 15 parts, each of which corresponds to 1 sq. in. of area; these parts are each divided into five subdivisions, and a vernier allows us to read to a tenth of a subdivision.

The instrument is designed to give the mean effective pressure of an indicator diagram directly. For this

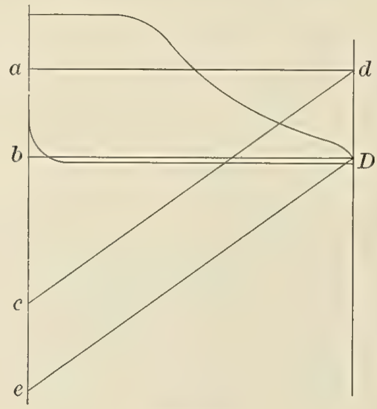


FIG. 15.

purpose the diagram is placed under a fixed clip with a vertical and a horizontal arm; in the figure the atmospheric line is brought to the edge of the horizontal arm, but if the engine has a vacuum it will be convenient to use a parallel line entirely below the diagram, such as the line of zero pressure. A movable clip is brought to the right-hand end of the diagram. A point at the right-hand end in contact with the clip, such as *D*, is chosen as the starting-point for measuring the diagram, which is traced toward the right in the usual way. Suppose that the wheel is set at zero before the figure is traced; then after the tracing-point has returned to *D* the reading of the wheel will give the arm of the diagram in square inches. If this area is divided by the length of the diagram, the quotient will be the mean height of the diagram, which may be set up at *Dd*, Fig. 15, and the equivalent rectangle *adDb* may be drawn. This rectangle is equal in area to the parallelogram *cdDe*, consequently if the tracing-arm is raised par-

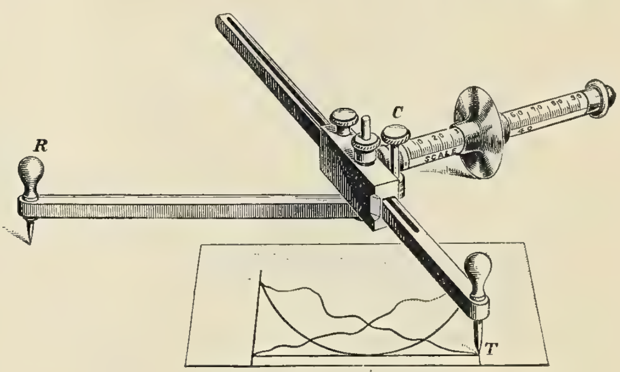


FIG. 16.

allel to itself with the tracing point against the clip till the wheel returns to zero, the tracing point will come to *d;* the distance *Dd* is the mean width of the diagram, and may be measured with the proper scale.

Fig. 16 represents Lippincott's planimeter, which,

like the Amsler planimeter, has a tracing-arm and a guiding-arm, but the wheel is on a perpendicular branch of the tracing-arm, as shown in the figure. This branch is a glass tube, which has a paper scale inside. The wheel is free to slide on the glass tube, but it has a sharp edge and cannot slide on the paper. An im-

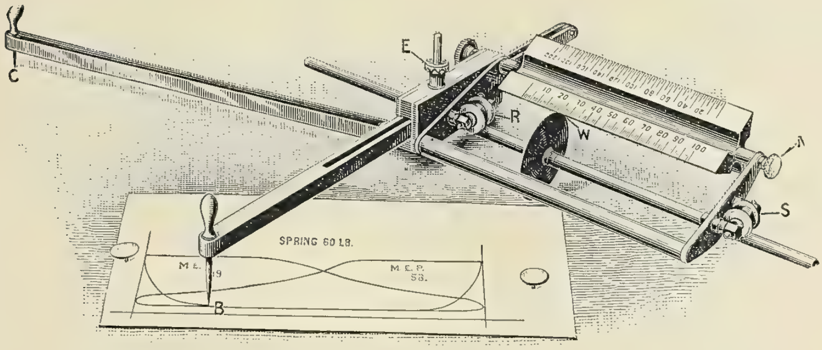


FIG. 17.

proved form of this instrument, known as the Willis planimeter, is shown by Fig. 17. The wheel W is carried by a rod, which passes under rollers at R and S, and moves over a scale MN which can be changed to correspond to the scale of the spring. If the tracing-arm is taken separately and moved over the rectangle $hpqi$, Fig. 18, the tube cd will draw through the wheel w, a distance equal to the width of the rectangle, or we may say that the wheel slides that distance on the arm. If the tracing-arm is 4 in. long and the area of the diagram is 10 sq. in., the wheel will slide 2 1-2 in.; one-tenth of this or 1-40th of an inch will consequently correspond to one square inch of area. If the tracing-arm is moved parallel to itself while the hinge h remains on the curve hi, Fig. 19, the wheel will roll from w to w'', and will slide a distance equal to the height of the figure; the length of the arm multiplied by the distance $w' w''$ is equal to the area of the figure.

If the arm hp is pivoted about a point as in Fig. 20 the arm cd at any instant will have two motions: (1) it will be drawn endwise through the wheel, and (2) it will swing around just as fast as the arm hp does; the first action affects the reading on the scale, and the sec-

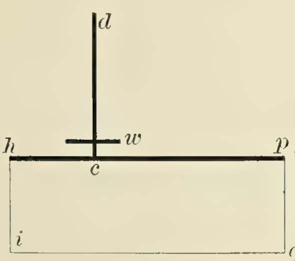


FIG. 18.

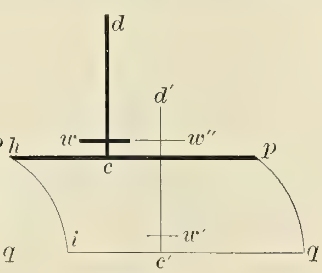


FIG. 19.

ond, which makes the wheel roll, does not. A little consideration will make it appear that the tube cd is drawn endwise a distance equal to the arc ce, as the arm hp swings to hr; and also that the distance the wheel slides on the tube cd does not depend on its position on the tube; it is true that the wheel rolls further when it is more remote from c, but that does not affect the reading.

We are now ready to consider a diagram $pqrs$, Fig. 9. As with Amsler's planimeter, there are four operations to consider: (1) the arm hp moves parallel to

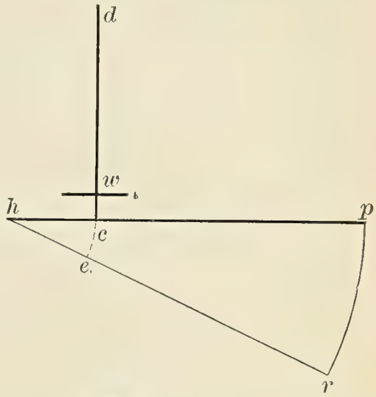


FIG. 20.

itself and the wheel measures the area $hpqi$; (2) the arm hp swings through the angle qir, and the wheel records the distance fg; (3) the arm moves parallel to itself and the wheel measures the area $rihs$; and (4) the arm swings through the angle shp, and the wheel records the distance ec. But ec is equal to fg, and is recorded in the contrary sense, and therefore the pivoting about i and about h have finally no influence on the reading. The instrument records finally the difference between the area $hpqi$ and $hsri$ because the latter is measured in contrary direction, or is subtracted, which gives the area of the figure $pqsr$. The extension of the action of the instrument from a figure like $pqsr$ to an irregular diagram is of course just like that given for the Amsler planimeter. This instrument, like the Amsler planimeter, could be used to measure large figures with the pivot inside the contour as in Figs. 12 and 13, if the tube cd were long enough, the discussion for establishing this proposition being almost identical with that given for Fig. 12; but as the tube is not long enough the instrument cannot be so used.

This instrument is commonly used to give the mean effective pressure of indicator diagram, much as the

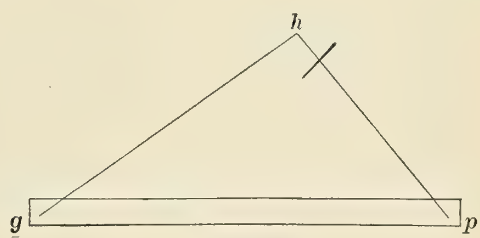


FIG. 21.

planimeter shown by Fig. 3 can be used. The tracing-arm is made equal to the length of an indicator diagram, and consequently the reading of the planimeter is equal to the mean width of the diagram in inches, or in pounds per square inch, depending on the gradation of the pa-

per scale inside the glass tube. Several tubes, with two scales each, are furnished with the instrument. A scale of inches and tenths can be used for measuring the width of a diagram in inches, or it may be used as a 10 scale or a 100 scale for reading mean effective pressures directly; other scales are conveniently arranged for various indicator springs.

Through the hinge of this instrument there is a style that is retracted by a spring, but it can be thrust down even with the tracing-point by pressing on its head. With this point pressed down the length of the tracing-arm can be conveniently made equal to the length of the diagram, when it is desired to determine the mean effective pressure of an indicator diagram. If the area of a diagram is desired the length of the tracing-arm can be set by direct comparison with a scale of inches; for example, the arm may be made four inches long and a scale of 40ths may be used for measuring area in square inches, ten 40ths corresponding to one square inch; or the arm may be made 5 in. long with a scale of 50ths in the glass tube.

It is claimed for the Lippincott and Willis planimeters that as the rolling of the wheel does not affect the reading, the wheel will not be spoiled by slight injuries to its edge. This might be true if the wheel rolled on a straight line as in Fig. 18, but lack of truth of the wheel will have some effect when the arm swings, as it will change the path on which the wheel rolls. It may be that slight injuries will have less injurious effect than with the wheel of the Amsler planimeter, but a planimeter that is properly handled and kept is not liable to suffer injury.

The truth and accuracy of any planimeter can be tested by tracing a figure of known area provided means be taken to make the tracing-point follow the outline exactly. Amsler's planimeter can be tested by using a slip of paper as a bridle to keep the tracing-point *p* at a constant distance from the pivot *g*, and thus tracing a circle with *g* at its center, as in Fig. 21.

New 750 Ft. Liner.—Following closely upon the construction of the Hamburg-American liner *Deutschland*, with an estimated rate of speed of 23 knots, comes an order from the North German Lloyd Line to the same builders—Vulcan Works at Stettin—for a larger and swifter vessel for the transatlantic trade. A few particulars of this new vessel given out show that in dimensions, power and speed she will far outclass any vessel previously constructed. It is stated that she will be about 750 ft. in length and will be propelled by engines of not less than 45,000 I. H. P., which will give her a sea speed considerably greater than the *Deutschland*. Rivalry between these two great German steamship corporations is intense, and may result in still further developments in the future, unless they follow the example of the British Union and Castle lines, and consolidate. The contest for supremacy between these two lines must be immensely to the satisfaction of the Emperor of Germany, who sees in every new fast liner an important addition to the Imperial fleets in time of war.

It has been decided to change the name of the American liner *Paris* to *Philadelphia* when she comes out again after reconstruction at the yard of Harland & Wolff, Belfast, Ireland.

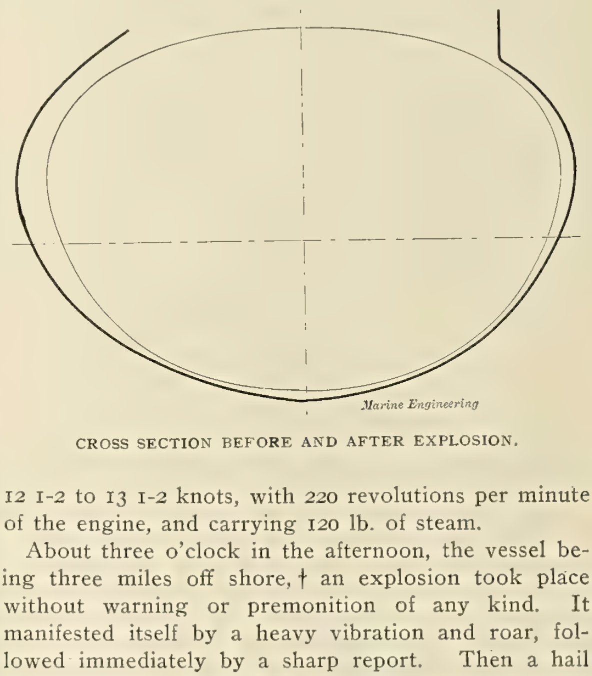
DISASTROUS BOILER EXPLOSION ON THE AUSTRIAN TORPEDO BOAT ADLER.*

BY J. HEINZ.

Since the wreck of the frigate *Radetzky*, which occurred thirty years ago, the Austrian navy has never had to record a greater disaster than that which occurred to H. M. Torpedo Boat *Adler* on July 22, 1899.

This vessel was built by Yarrow & Company, Ltd., London, in 1885, and was of the following dimensions: Length, 135 ft.; beam, 13 ft. 9 in.; mean draft, 5 ft. 6 in.; displacement, 95 tons, and bunker capacity, 28 tons. The engine developed a maximum power of 1,200 I. H. P., giving a speed of 22.2 knots. The boiler was built by Hicks & Hargreaves, of Bolton, Manchester, England, and was of the locomotive type, as adapted for marine work, and was connected to two funnels placed athwartships of each other.

The vessel had been ordered in commission for the summer of 1899, and after the usual overhauling, cleaning and scaling, and dock trial, she left her anchorage at Teodo at 6 A. M., July 22, for a run to Sebenico. The crew consisted of 17 men. As is customary for long runs, she was run under reduced speed, making



CROSS SECTION BEFORE AND AFTER EXPLOSION.

12 1-2 to 13 1-2 knots, with 220 revolutions per minute of the engine, and carrying 120 lb. of steam.

About three o'clock in the afternoon, the vessel being three miles off shore,† an explosion took place without warning or premonition of any kind. It manifested itself by a heavy vibration and roar, followed immediately by a sharp report. Then a hail of splinters fell on the deck and a shower of hot water from the boiler fell on the after deck. For a time the vessel was enveloped in a cloud of steam, and after this had disappeared the survivors were able to get an idea of the damage. Of the crew, two were killed by falling timbers, three were hurled out of the vessel and drowned, and four were more or less injured. The deck over the boiler room was torn up and showed a gaping hole, as the boiler had torn itself from its fastenings by the reaction of the escaping steam and had hurled itself bodily overboard. The mast of the ves-

*Translated from the original German of *Mittheilungen aus dem Gebeite des Seewesens*, Pola, Austria.

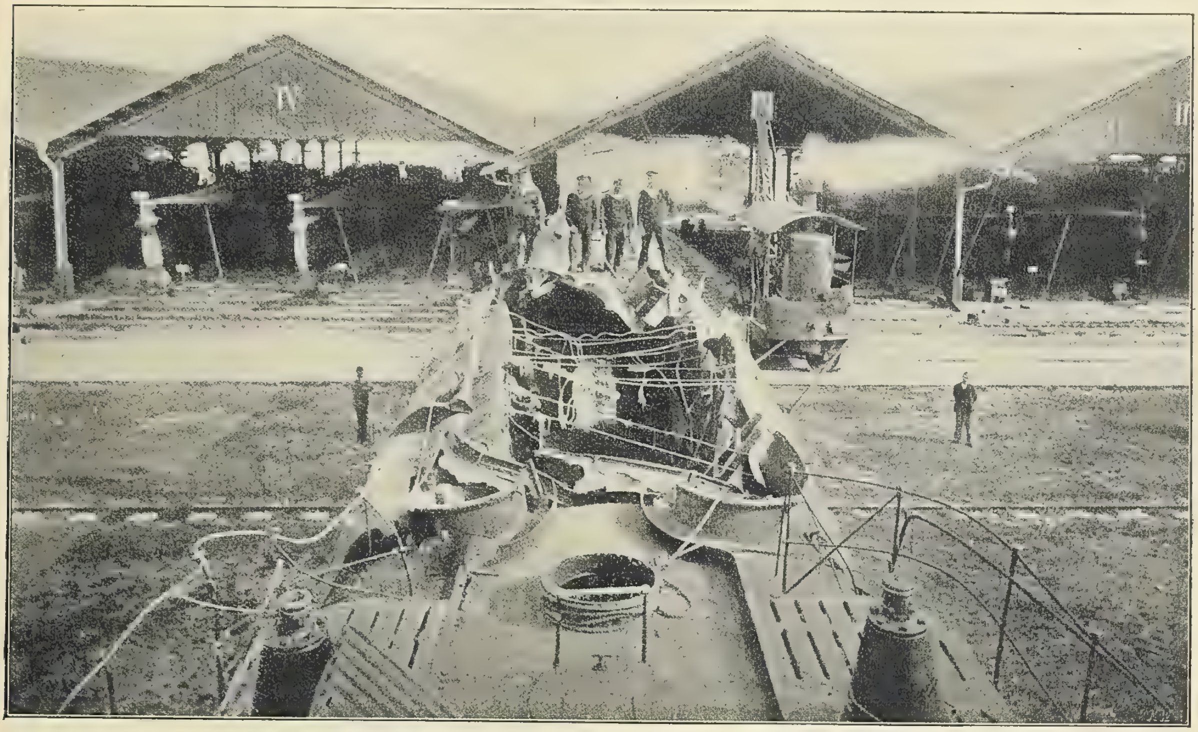
†The disaster occurred while the *Adler* was steaming in the Adriatic Sea, near the Isle of Lesina, off the coast of Dalmatia.—Ed.M.E.

sel flew upward and fell on the deck, the starboard stack hung over the side of the vessel, and the port stack was bent forward. The bulkhead between the engine and boiler rooms was broken through at its upper parts, and all gear on deck above the boiler room, such as small boats, etc., had disappeared. The deck aft of the boiler room looked like a scrap pile, but the deck forward suffered little damage.

After an unsuccessful attempt to rescue one of their comrades who was hurled overboard, the survivors set to work to save what was left of the vessel, as she began to roll heavily and shipped water. A sail was rigged with awnings and spare spars, and she was laboriously worked to shore and beached. The engine and boiler rooms had meanwhile filled to the water level. Divers were sent down to stop the leaks, and after the boat was pumped out she was towed to the naval station at Pola for survey and investigation. A comparison between the boiler, with the exception of those which were covered with coal. Of the two main steam pipes, the port pipe had torn off at the boiler stop valve, but was intact, while the starboard pipe was sheared off at the engine room bulkhead. The entire engine space was intact, except that it was filled with soot and ashes.

The boiler was 18 ft. long, the cylindrical part was 7 ft. 7 1-2 in. dia., 8 ft. 9 in. between tube sheets; grate surface, 40 sq. ft.; working pressure, 150 lb. The boiler weighed 35,300 lb. when empty. The boiler was one of the largest of its kind, and was a duplicate of the one on the sister boat, the *Falke*. The fire box was made of copper plate, the tubes of brass, and all mountings were in duplicate.

The boiler, although built in 1885, had seen very little service. It had been tested with cold water pressure to 240 lb. per square inch four months previous



APPEARANCE OF BOILER ROOM FROM THE DECK OF THE ADLER SUBSEQUENT TO THE EXPLOSION—PHOTOGRAPHED AT POLA.

the vertical section through the boiler room before and after the explosion showed that the pressure due to the reaction of the steam had bulged out the sides and the bottom, and portions of the framing which, on superficial examination, seemed to be sound, were tested and found to have far exceeded the elastic limit. The boiler breeching was intact at its lower end, but the upper part was badly injured. The boiler saddles were partly bent and partly torn off, and the ash pan still remained in place, although bent. Among the ashes and clinkers which remained in the ash pan were found copper rivet heads and sheared rivets, which had come from the fire box seams, as well as pieces of sheared staybolt threads. The boiler mountings had all gone with the boiler, with the exception of one safety valve, which was picked up in a damaged state. The stokehole floor plates had also gone with to the accident, and had also a dock steam trial with full boiler pressure. Furthermore, it had been caulked and several staybolts renewed.

According to the testimony of the survivors of the crew, the boiler had had an examination and cleaning two days previous to the accident. The braces and tubes were found clean, and the vertical stays were slightly rusted. There were no defects of any kind, with the exception of a slight pitting at the bottom hand holes. The refuse removed during cleaning consisted only of rust scales. There was no doubt that all accessible parts of the boiler were clean, but the condition of the bottom of the water legs unfortunately could not be ascertained. The boiler feed had always been fresh water, and the water level indicators were always in good condition. The amount of auxiliary feed required was minimal, and the salinometer tests

had shown the water to be pure. As the boiler room crew had been killed, it was impossible to find out the exact state of affairs shortly before the explosion, but it was noticed that an hour and a half previously water stood slightly high in the glasses.

The commissioners appointed to investigate the cause of the explosion were convinced that the rupture occurred in the seam at or near the top of the fire box. No definite reason could be assigned to the cause of the break.

An attempt was made to drag the bottom of the sea at the place of accident to recover the boiler and thus get better evidence. Four navy vessels worked for twelve successive days at this task, using every modern appliance, but were unsuccessful, as the water at that spot averaged 230 ft. in depth, and the bottom consisted of jagged rock and coral, with steep declivities.

The possible causes of the rupture of the fire box could have been either a heavy deposit of scale, or low water. The first conjecture, of course, is out of the question. The second could have occurred, as follows: The feed pumps had always been in prime condition, and there may have been a possibility that, knowing this, the crew had been somewhat negligent in attending to them, and a probable stoppage of feed might have been the cause, as it was stated that the quantity of water in the boiler could be evaporated in seventy minutes. Then again, an examination of the water chamber of the pump shortly after the accident revealed that the contained water was salty, and therefore a probability that a sudden breakage of a condenser tube or leakage in the condenser would account for the extra height of water in the glass previous to the accident.

Port at Montauk Point.—The control of the Long Island (N. Y.) Railroad passing into the hands of the Pennsylvania R. R. recently has revived rumors of the construction of a great railroad and steamship terminal at Montauk Point for transatlantic trade. The Point is about 117 miles by rail from New York city, and were passengers to be put ashore there instead of coming up to New York by water the duration of a transatlantic trip would be shortened by about seven hours.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—II.

BY ROBERT H. THURSTON.

In Illustration, let it be required to ascertain the Carnot efficiency and the values of these quantities for cases in which the initial pressures range from 160 down to 60 lb., while the back-pressure is constant at 4 lb. In this, as in all other cases, the work is all performed by transformation of latent heat of expansion; all energy, U, furnished the cycle is latent heat, H_1, and the efficiency is $E = (T_1 - T_2) / T_1$; while the work done is always measured by the expression $U = EH_1$. Then the quantity of heat, of steam, or of fuel required to supply the precise equivalent of the conventional horse-power, 1,980,000 foot-pounds per hour, or 33,000 per minute, as, for example, when 10,000 *B. T. U.* being taken as the heat-content, so far as available, of the fuel, we invariably have for the measure of these quantities for efficiency unity, 2,545 *B. T. U.*, 0.2 pounds of fuel 2,545 / H_1 pounds of steam per horse-power-hour, These figures, divided by the computed actual efficiency of the cycle, give the measures of the quantities of heat, steam and fuel demanded by the cycle per horse-power-hour. These quantities have been computed and tabulated, as in Table I, for the above assumed range and conditions.

TABLE I.—IDEAL EFFICIENCY OF CARNOT CYCLE CONDENSING.

Initial steam pressure # per sq. in.	p_1	160	140	120	100	80	60
Initial steam pres. # per sq. ft.	P_1	23,040	20,160	17,280	14,400	11,520	8,640
Initial temp. deg. Fahr.	t_1	363.346	352.827	341.058	327.625	311.866	292.575
Volume of 1# water at initial pressure	V_0	.0160	.0160	.0160	.0160	.0160	.0160
Volume 1# steam at init. st. pr.	V_1	2.786	3.161	3.656	4.342	5.358	7.024
Back pressure # per sq. in.	p_2	4	4	4	4	4	4
Back pressure # per sq. ft.	P_2	576	576	576	576	576	576
Temp. at back pressure	t_2	153.122	153.122	153.122	153.122	153.122	153.122
Vol. at end of ex. p. per app. form	U_2'	71.85	72.45	73.17	73.96	75.03	76.33
Ratio of expansion per app. form	r.'	25.79	22.92	20.02	17.03	14.00	10.87
Vol. at end of expansion	U_2	71.76	72.54	73.69	74.36	74.77	76.56
Ratio of expansion	r.	25.75	22.95	20.16	17.12	13.95	10.89
Thermodynamic efficiency	E.	.255	.245	.234	.221	.205	185
Latent heat of 1# steam at in. pr.	L	857.912	865.552	874.076	883.773	895.108	908.928
Work per stroke in B. T. U.		218.77	212.06	204.53	195.31	183.50	168.15
Work per stroke in ft. lbs.	W	170,203	164,983	159,124	151,951	142,763	130,821
Horse power per stroke per min.	H.P.	5.16	5.00	4.82	4.60	4.33	3.96
M. E. P. in # sq. in.	p_E	16.47	15.79	14.99	14.19	13.26	11.87
M. E. P. in # sq. ft.	P_E	2,371.8	2,274.3	2,159.3	2,043.4	1,909.3	1,708.7
Steam per H.P. per hr.		11.63	12.00	12.44	13.05	13.87	15.13
B. T. U. per H.P. per hr.		9,980.39	10,387.75	10,876.07	11,515.84	12,414.63	13,766.75
Fuel per H. P. per hr.		.998	1.0387	1.0876	1.1515	1.2414	1.3756
Volume traversed by piston, per H. P. per minute		13.90	14.51	15.29	16.16	17.27	19.33

Comparing the figures, it is seen that, could the engineer approximate the ideal case with his real engine, he could obtain the horse-power at the cost of but from 11.9 to 16.5 lb. of steam per hour with condensing engines, adjusted as assumed. The back-pressures, which have been taken to correspond, for special purposes of comparison, with the data given by Rankine, are, in these cases, however, altogether too high, and a vacuum 2 lb. better, and with a more than corresponding gain, is often reached, reducing these figures something like 15 per cent for the best known cases.

The Rankine Standards are those which are commonly taken for employment when it is desired to ascertain what are the magnitudes of the more or less avoidable wastes of the steam-engine. Of these there are two:—

The Rankine Adiabatic Cycle is one in which steam is assumed to enter a non-conducting cylinder, to be expanded to terminal pressure, adiabatically, to be free-

ly exhausted, with uniform and minimum back-pressure and completely rejected, no clearance or compression being allowed.

The Rankine Jacketed-Engine Cycle is one in which steam, entering as before, is expanded in a cylinder capable, as by the use of a jacket or otherwise, of supplying it with all the heat needed, in the course of the expansion period, to keep it precisely dry and saturated, up to the instant of opening the exhaust port. The remainder of the cycle is similar to that of the adiabatic cycle.

The computation of these ideal cycles may be made by processes of great simplicity and ingenuity, fully described by their author, and now quite familiar to the professional engineer. They need not be here described in detail.[1]

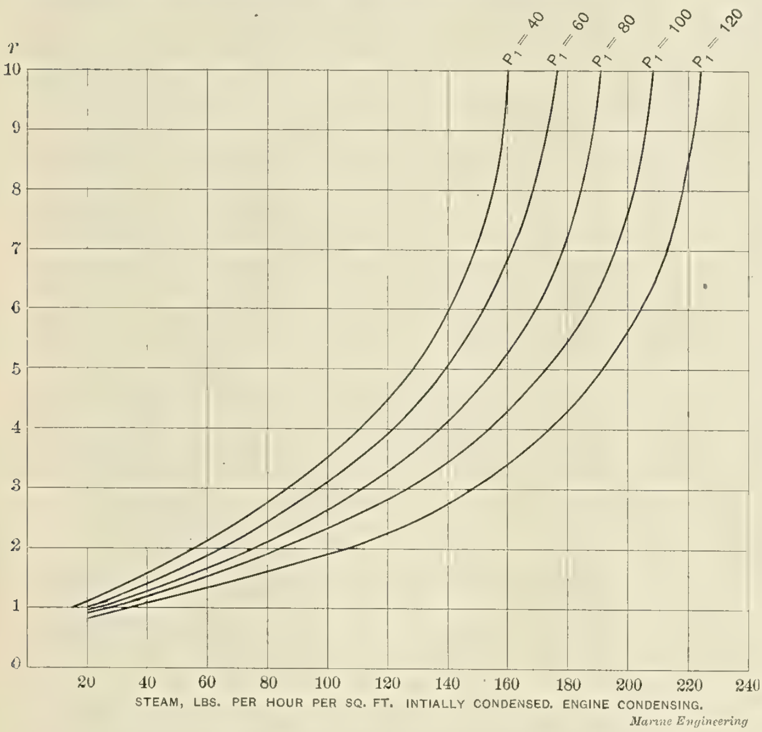


FIG. 3.—CYLINDER CONDENSATION AT MODERATE SPEEDS OF ENGINE.

Of the two type-cycles, that known as the jacketed engine cycle is more nearly illustrated by the real engine, where its jacketing is effective, than is the other. No engine-cylinder, as yet, has been made adiabatic in its action.

The data assumed for a Rankine jacketed-engine cycle, as follows, are as nearly those of an actual case in practice as it is possible to make them.

TABLE II.

DATA FOR COMPUTATIONS AND RESULTS.

$p_1=121.6+14.5=136.1$; $p_3=2.8$ lbs. per square inch; $T_1=811.8°$ F. Correct efficiency, 0.283.

r	p_2	T_2	V_2	U	Thermal Efficiency.	Steam per H P. per hour$=W'$.
15	7.68	642.2	48.93	206,600	0.232	9.61
20	5.55	628.0	66.40	214,600	.252	9.23
25	4.41	618.3	82.50	219,000	.258	9 02
30	3.63	610.5	98.90	220,380	.259	8.98
35	3.09	604.1	115.25	222,070	.261	8.92

The wastes for such cases may be approximately computed, and, if added to the above expenditures, the sum will presumably be approximately the actual expenditure of the engine; always provided the design and construction be so well and so intelligently carried out as to permit the operation of the machine to be representative of good contemporary practice.

The two formulas most commonly employed in the computation of probable wastes by cylinder condensation, the most remarkable of those wastes which distinguish the real from the ideal case, are the following, in which W is the weight of steam condensed per hour, and W^1 that computed for the ideal case:

$$W=CA(T_1-T_2)t; \quad W'=(W^1 a\sqrt{t})\div D.$$

A and a are constants determined by experiment; t is the time of one stroke in seconds; and D is the diameter of the steam-cylinder in inches, A its internal superficies in feet.[3]

The magnitude of this waste is rarely fully realized, and the diagram, Fig. 3, illustrating the results of research extending over a long period of time and by a number of observers, as collated, compared and pruned of errors of observation in such manner as to permit their representation by smooth and regularly varying curves, rectified for both curvature and locus, by the writer, may prove instructive. The case is that of one of the experimental engines of Sibley College, and shows how, with engines of moderate size and of moderate speed, 80 to 90 revolutions with 3 ft. stroke of piston, the measured amount of steam condensed on the unit area of internal surface of the cylinder wall varies with the degree of expansion and the changing steam-pressures.

It is seen that, in this case, the wastes are less as the ratio of expansion is less as the steam "follows" farther, and also as the boiler-pressure is reduced. These differences, great at first, become rapidly less as the ratio of expansion increases, the total waste varying pretty nearly as the square foot of the ratio of expansion.

S. S. GROSSER KURFURST.—The *Grosser Kurfurst*, of the North German Lloyd Line, arrived at the port of New York last month on her first transatlantic trip. She is one of the intermediate type of vessels of the fleet, with enormous carrying capacity and excellent passenger accommodation for all classes. Last winter this fine vessel was first put into service, making a trip to Asiatic and Australian ports in the company's service in those waters. She is a product of the Schichau Yard at Danzig. Her dimensions are:: Length, 581 ft. 6 in.; beam, 62 ft.; depth, 39 ft.; gross tonnage, 12,200 tons; displacement, 22,000 tons. She is fitted with twin screws, driven by quadruple expansion, navy pattern, balanced engines, with cylinders, 27 3-8 in., 41 in., 59 in. and 83 1-2 in. dia. and 53 1-8 in. stroke.

[1] See Rankine's Manual of the Steam-Engine, or Thurston's Manual, Vol. I., Chapter V.

[2] For the Rankine equations, see either Rankine's *Steam Engine and other Prime Movers*, or the writer's *Manual of the Steam-Engine*, Vol. I. For the treatment of the real, as distinguished from the ideal, case, see the latter, and especially Chaps. V. and VI.

[3] *Manual of the Steam-Engine*, Vol. I., Chap. VI.

SYSTEM OF WORK ADOPTED IN A SHIPYARD ON THE GREAT LAKES—I.*

BY W. I. BABCOCK.

While the systems used in the construction of the hulls of modern steel vessels are somewhat the same in all lake yards, it is the purpose of the following article to describe the practice of the Chicago Ship Building Co. only, and that as applied to the ordinary lake bulk freight vessel of large size. For a proper understanding of what follows, it is necessary first to describe the ship itself, inasmuch as the requirements of the service have developed a somewhat peculiar type of vessel.

The great majority of modern steel lake vessels are designed to carry only iron ore, coal, or grain in bulk, and no deck, therefore, is required or laid on the main-deck beams in the cargo holds. The movement of ore and grain is entirely from upper to lower lake ports, and of coal in the opposite direction. As, however, there are a great many wooden vessels still in service which require up-cargoes, and coal cannot be unloaded rapidly, the freight rate on coal is seldom attractive, and the big steamers, especially those belonging to the great ore and steel companies, go back light, using water ballast alone when any is required.

The season of navigation being limited by ice to about seven months in the year, despatch in port is of the utmost necessity, and as the cargoes are all spouted in, the ore and coal from elevated docks and the grain from elevators, and taken out by machinery on the docks, hatches are many in number, and no hoisting machinery is carried on the ships themselves.

The connecting channels between the lakes being comparatively shallow, the vessels are built with a plate keel, very flat floor and full model to get as great capacity as possible on the limited draught available, and a large number of frames amidships are exactly alike, as many as one-half to two-thirds the total number. When coming light to a loading dock, they therefore float very high out of water, and to obtain the necessary slope to the spouts the hatches are made as wide as possible athwartships, leaving only stringer enough for strength on each side. While it is true that the upper deck could be depressed by filling the water bottom, this would cause a loss of time in loading, as it is evident that the cargo can be run in much faster than the water could be pumped out, and is, therefore, not allowable.

The longest straight run in open water is across Lake Superior, about 400 miles, the total voyage being under 1,000 miles. Coal for fuel being available at various points in the connecting rivers, no great bunker capacity is required, and, the fuel hatches opening in all cases through the upper deck, a few minutes suffices to spout in the amount desired from elevated pockets. At lower lake ports it is usual while the cargo is discharging to fuel from a lighter alongside provided with a hoisting derrick reaching into the fuel hatch.

The danger of grounding in the narrow, tortuous, and in many places rocky channels connecting the lakes themselves being considerable, double bottoms are a necessity and are carried straight across on top to protect the bilge to the upper turn. To get sufficient water ballast, as well as to raise up an ore cargo and make the ship easier in a seaway, the tank is made deep, from 5 to 6 ft. at the center line. Carrying the cargo at this height above the floors requires heavily stiffened and closely spaced girders or longitudinals, which are intercostalled between floors to further support them and the bottom plating against grounding strains. The use of channel floors for the flat of bottom is now universal, and results in a considerable saving in first cost, as well as avoiding the continual shearing of frame rivets and cracking of frames through the rivet holes from grounding when the bottom construction is the ordinary plate floor with frame and reverse bar.

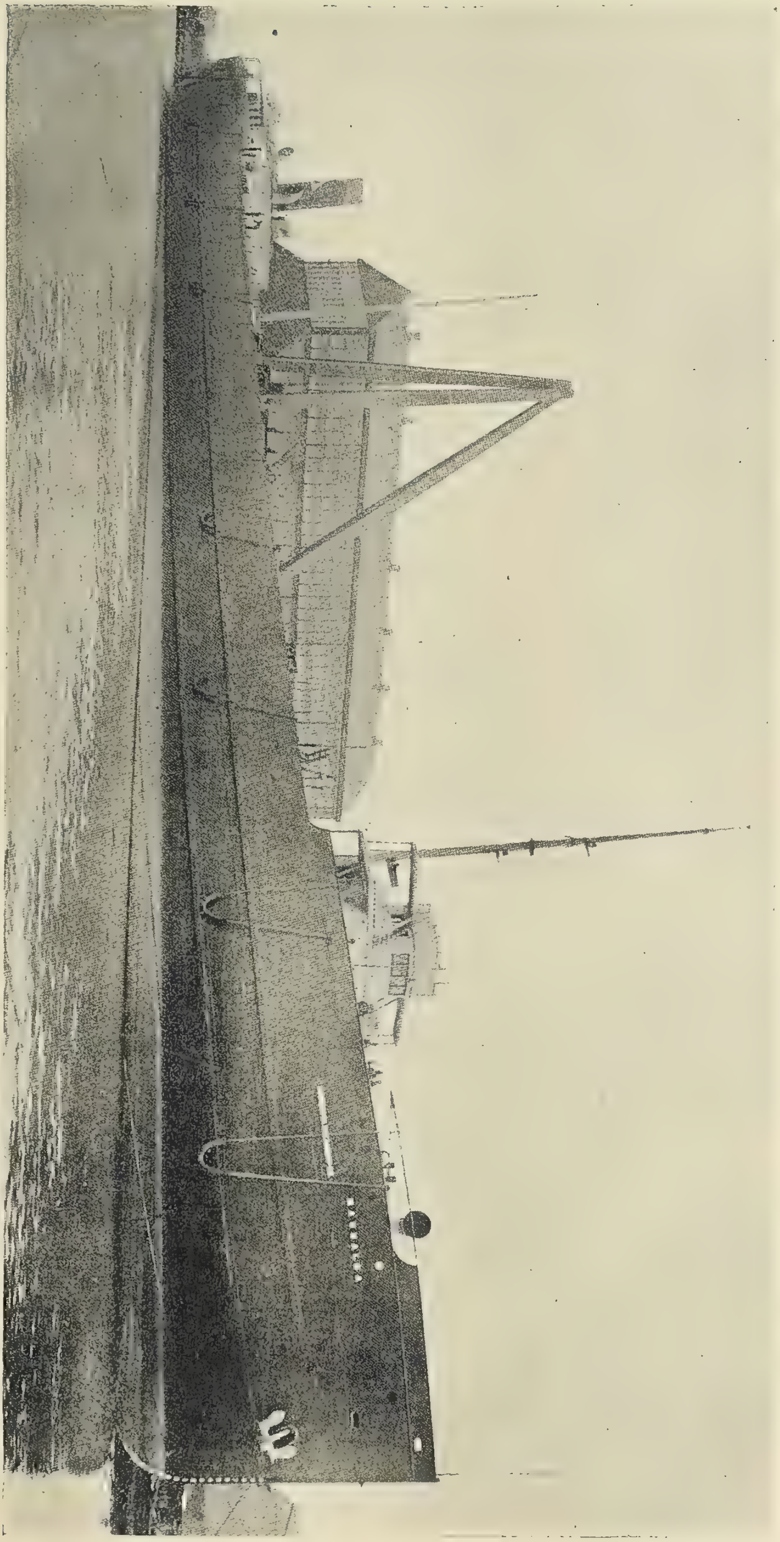
Ore and coal loading docks having the spouts uniformly 12 ft. centers, all hatches are spaced 24 ft. centers fore and aft, and the frame spacing is always 24 in., no matter how large the ship, the frames being channels. Hatches are 8 ft. fore and aft and channel web frames or belts are spaced every 8 ft., making one belt at each hatch beam and one in the center between hatches, on which a main-deck beam is also placed. To avoid interruption of the loading spouts by machinery spaces, as well as to avoid the inconvenience of a shaft alley in the cargo hold, the machinery is placed aft, the engine going as near the stern-post as the shape of the ship will permit, and the boilers and bunkers being next forward, either in the hold or on a raised deck, with cargo space beneath.

From all of the above considerations a type of vessel has been developed, of which the S. S. *Mauna Loa*, of the Minnesota Steamship Co., just completed in the Chicago yard, shown in the accompanying engraving, may be considered a fair example. The ship is 430 ft. keel, 450 ft. over all, 50 ft. moulded beam, and 28 1-2 ft. moulded depth, with a 5 1-2 ft. water bottom. She is propelled by a quadruple-expansion, four-crank, jet condensing engine of 2,500 H.P., taking steam at 250 lb. pressure from two Babcock & Wilcox marine water-tube boilers. The light-load displacement is about 3,200 net tons, and on 18 ft. 3 inch draft she carried 6,816 gross tons of iron ore. The water ballast capacity is 2,900 net tons. Speed, loaded, 12 statute miles per hour, and light, 14 miles.

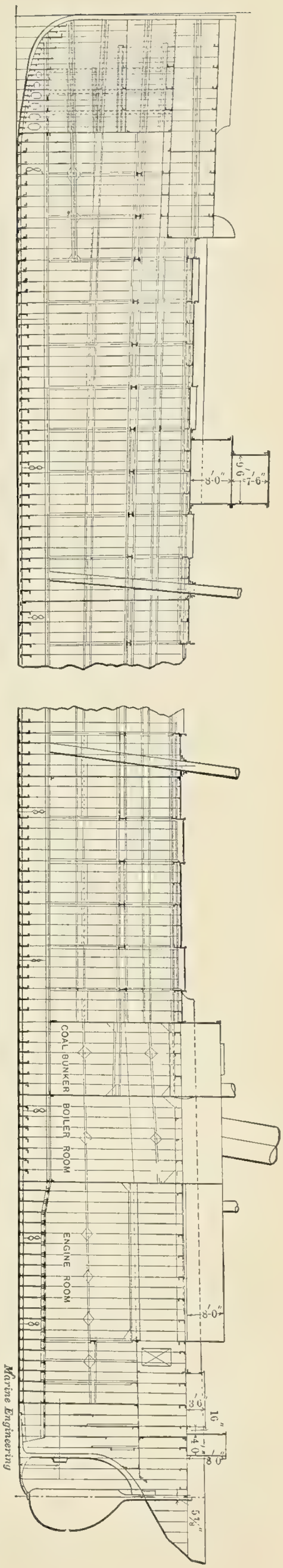
The system used in the Chicago yard in constructing this ship and similar vessels is as follows:

The general dimensions, midship section, and positions of hatches and bulkheads having been agreed upon, a model is prepared, and from it the length of the straight midship portion of the ship determined. At the same time, a butt plan of the keel, bottom plating, center keelson, rider, longitudinals, tank margin, and all fore and aft angles is prepared, and on the mould-loft floor a reproduction of the midship section drawing is made full size. From this the widths of the various bottom and bilge plates are measured exactly, the necessary allowances made on the outside plates for bevel shearing and the mill orders prepared at once. Wooden templets for the brackets at center keelson, bilges, tank top, and deck beams are made with the necessary allowance for flanged edges and sent direct to the plate mill, so that all these brackets come into the yard

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.



PHOTOGRAPH OF LAKE STEAMER MAUNA LOA (450 FT. LONG, 6,800 TONS CAPACITY) WHEN LIGHT AND LYING ALONGSIDE WHARF AT BUILDERS' YARDS.



Marine Engineering

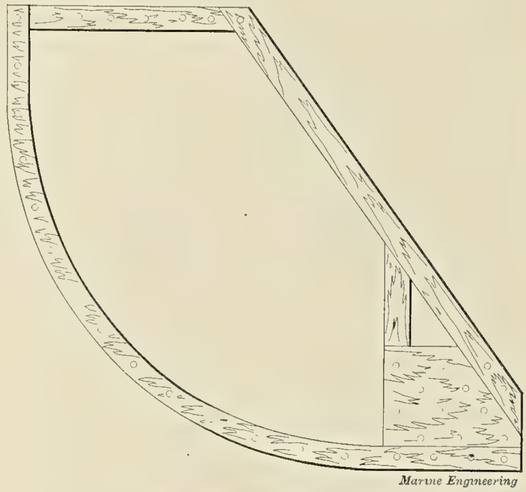
FORWARD AND AFTER ENDS OF STEEL LAKE FREIGHT STEAMER MAUNA LOA BUILT BY CHICAGO SHIPBUILDING CO., SOUTH CHICAGO, ILL.

sheared to exact size. The lengths of the channels for floors and tank-top seam straps, and of the angles for the keelson and longitudinal stiffeners, bilge frames, etc., are taken directly from the floor and orders sent to mill.

It will be understood, of course, that as there are a large number of dead flat frames—114 in this ship—this enables a large quantity of material, both plate and shapes, to be ordered in duplicate pieces from the floor very quickly from the midship section only, and without waiting for the body plans to be completed.

After the lines are faired and the body plans completed on the floor, the remainder of the ship is ordered in the usual manner. The laying down in the loft being completed, the next step is the making of the wooden moulds. For the straight part of the vessel amidships, below the tank top, it is evident that one mould only is required for the channel floors, with strip (narrow) moulds for top and bottom flanges, one for the ordinary bilge brackets, and one for the belt bilge brackets, from which all are punched. Also that one mould each suffices for the center vertical keelson and rider for all the plates from the forward collision to the engine bulkheads, the keelson being of uniform depth, and one keel mould answers for all the keel plates until the floor line at either end leaves the dead-rise line within the half breadth of the keel plate. For this keel mould, as well as for all moulds for butted plates, strips of lignum-vitæ, adjustable for screws, are fitted into the ends, so that any variation in length from swelling or shrinking of the pine from which the mould is made can be taken up and the exact length secured. When lapped butts are used this refinement is not required. One mould also answers for nearly all of the center vertical keelson brackets; two moulds for C. V. K. angles, one for each flange; one for the stiffeners of each longitudinal for all the flat of bottom; two for keel bars; two for top C. V. K. angles; two for channel seam straps under tank top; two each for top and bottom longitudinal angles; one for the high plate floors dividing the separate compartments of the water bottom. For the skin plating on the flat of bottom one mould suffices for all the plates in each strake. Similarly, one mould answers for all the tank-top plates except where the water-tight floors would come at a seam, which is undesirable for water-tightness, and, therefore, avoided by putting in a narrow plate, and one mould for all the tank-top margin plates amidships.

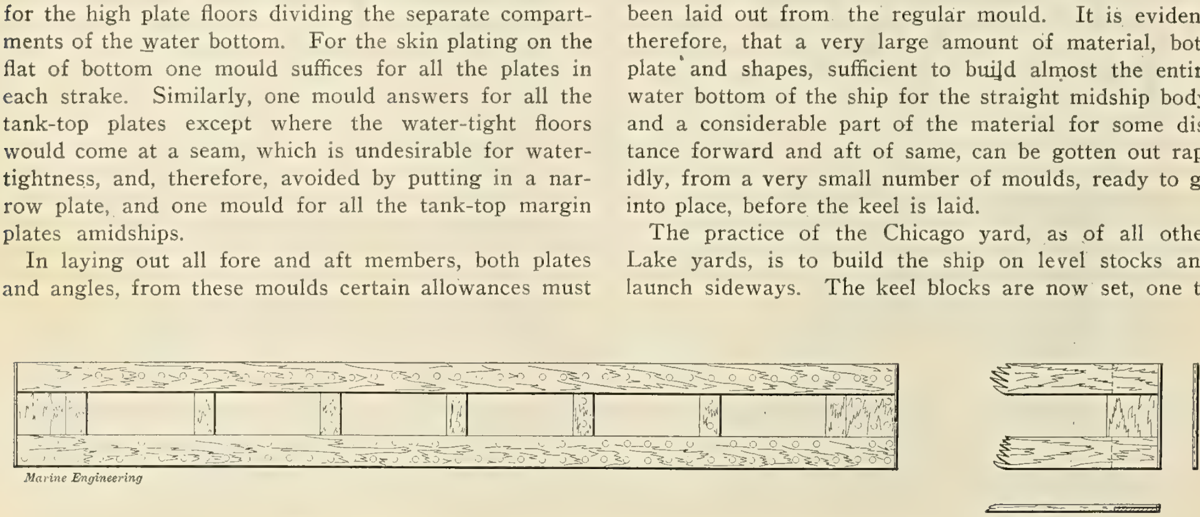
In laying out all fore and aft members, both plates and angles, from these moulds certain allowances must be made, as follows: Where the turning space comes —that is, where the siding flange of frames and floors changes from looking aft to looking forward—the distance between frame rivets, instead of being exactly 24 in., is less by twice the distance from heel of floor to center of rivet, and the mould must be moved up that amount. Where the water-tight plate floors come, the moulding side of the frame is moved a distance equal to the thickness of the plate, as is also one center keelson stiffener, the rivet spacing is lessened for water-tightness, and extra holes put in on outside strakes of bottom plating for the wide liners. At the belt floors, the small bracket connecting the longitudinal stiffener to the channel seam strap shifts the stiffener over by the thickness of the bracket and necessitates a liner of corresponding thickness, between the stiffener and the floor. And wherever a butt comes in an adjoining member, requiring different spacing of rivets, these must be allowed for.



BILGE BRACKET MOULD.

In all such cases, "space moulds," covering only the particular frame space in which the change is necessary, are applied after the remainder of the member has been laid out from the regular mould. It is evident, therefore, that a very large amount of material, both plate and shapes, sufficient to build almost the entire water bottom of the ship for the straight midship body, and a considerable part of the material for some distance forward and aft of same, can be gotten out rapidly, from a very small number of moulds, ready to go into place, before the keel is laid.

The practice of the Chicago yard, as of all other Lake yards, is to build the ship on level stocks and launch sideways. The keel blocks are now set, one to each keel plate, by a surveyor's level, and the center line put in by a transit instrument, the keel plates are strung along on them, the butt straps and liners bolted up and four tack rivets driven by hand in each strap to avoid possibility of shifting. Then one keel bar is put



MOULD FOR ONE-HALF OF KEEL—UPPER EDGE CENTER LINE OF KEEL.

up, the center vertical keelson plates and butt straps, the other keel bar, keelson top angles and stiffeners and all carefully bolted and reamed. A large amount of work is thus ready for the pneumatic yoke riveters, which are then started and the whole keelson riveted and caulked water-tight.

In the meantime the various parts composing the floors have been punched, assembled on a long line of skids extending from the stationary steam riveter, tested by the mould, bolted carefully and reamed by pneumatic drill and riveted. It will be noticed that of all these pieces—namely, the channel floor, center keelson bracket, bilge bracket, bilge frame, longitudinal stiffeners and clips—only one piece, the bilge frame angle, has any curve to it. This angle is bent cold between two collars temporarily bolted to the upper roll of the shipyard bending rolls, the bilge being made an arc of a circle to facilitate this rolling as well as that of the bilge strakes of the hull plating. For more than half the length of the ship, therefore, there is no furnace or forge work in any part of the water bottom except the few angle collars required to make water-tight work at the tank divisions. This applies also to a considerable part of the water bottom forward and aft of the straight midship body, and, as will be seen hereafter, to a large part of the ship above the tank top.

Forward and aft of the midship body the channel floors are continually growing shorter and the bilge brackets longer, as the extremities are approached. The bilge bracket soon becomes too large if its inner edge is kept straight, and it is, therefore, cut out to a curve and fitted with a reverse frame. When the channel diminishes to about 6 ft. in length its use is abandoned and ordinary plate floors with frame and reverse frame substituted.

While one diminish mould for each body answers for the floor channels, separate moulds for each bilge bracket must be made. When bolting the various parts together, however, to make the complete floor, the same test moulds answer as are used for amidships, the position of the outboard upper point of each frame being marked upon them, so that all the floors from one end to the other of the water bottom are completed and riveted at one time.

The center keelson having been riveted and caulked, heavy floor ribbands are now erected at each side at a distance from the keel just inside the extremities of the floor channels. The garboard plates are now raised into position, bolted to the keel plate on the inner edge and held up by temporary vertical shores near the outer edge. Similarly the other strakes of the bottom plating for all the flat part of the bottom are put up in succession and supported in the same way. The total weight being small, only very light shoring is required. The floors are now brought over by a locomotive crane from where they were stored, after being riveted on the bull machine, and dropped into place on top of the bottom plating by the overhead traveling crane. The inner end rests on the keel and the outer end on the floor ribband, a bolt or two through the bracket and keelson stiffeners being put in at the same time. Quickly thereafter the longitudinals and intercostals are put in, the channel seam straps rove across, and the whole carefully leveled and squared up, one or two tank-top plates being put on to hold everything secure.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—III.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

PERSONNEL.

Efficiency of the personnel is universally recognized as of supreme importance.

In no direction does this manifest itself in a more marked degree than in the intense and continuous effort shown abroad to train gun pointers, with the object of having them attain the greatest possible practical efficiency. Prior to the war with Spain the published statements of results of foreign target practice gave some remarkable percentages of hits. Since the war, owing to greatly increased interest in the subject, still better results are said to have been achieved.

Not making sufficient allowance, perhaps, for battle conditions, foreign analysis of the effects of gun fire at Manila and at Santiago generally results in the assertion or points to the inference that the American gun pointers showed much room for improvement, both in the accuracy and in the rapidity of their fire, although they were vastly superior to the Spanish. In so far as these discussions are derogatory to the American gun pointers the comment is appropriate that never before have fleets been so utterly destroyed through gun fire.

In the British navy the allowance of ammunition for target practice and the amounts paid for prize firing have, it is stated in the press, been largely increased within the past year. The *Excellent* gunnery training establishment on Whale Island has been enlarged, and improvements are making to increase the facilities for target practice. The Sheerness gunnery school is reported in the press to be undergoing enlargement. English newspapers report negotiations in progress to secure land to permit the *Cambridge* gunnery school at Devonport to be established on shore, in accordance with the method followed at Whale Island. The same plan adopted there will probably be adhered to of having vessels to carry details to sea frequently for target practice, underway, under varying conditions of weather.

In the French navy the training of gun pointers has for some time past been a matter of special effort, and since the recent war these efforts have been redoubled. The exercises appear from press accounts to be of a very practical nature.

In the German navy prizes are offered for successful target firing to a greater extent than formerly, and nothing is left undone to stimulate interest in the practice. Press reports show that the vessels in commission at Kiel and Wilhelmshaven go to sea almost every day for target practice, which is not confined, as formerly, to their going out for manœuvres. Target practice is no longer confined to ships in commission; but also includes the vessels in reserve, which go out with reduced complements, in order to familiarize the personnel with the ships and to keep the vessels in serviceable condition.

Training is by no means confined to target practice,

*From Notes on Naval Progress issued by U. S. Office of Naval Intelligence, Washington, D. C.

but goes on actively in every practicable way in all important foreign navies.

The tendency is very marked abroad to have men who are selected for special courses of instruction, as well as those awaiting distribution to the fleet, quartered in barracks ashore rather than on board of old hulks. It is found that better hygienic conditions can be obtained in barracks, and the results are more satisfactory in many ways.

Rapid coaling is now regarded as an essential requirement of the personnel and has received much attention, particularly in the British navy, where it is no longer regarded as mere drudgery, but has become an important evolution in which officers as well as men often take part, the greatest rivalry existing among the ships of a squadron.

Items which have appeared recently in English newspapers indicate that, through thorough training of the fire-room force, marked progress has been made in the extremely important matter of diminishing the amount of smoke discharged from the smoke pipes.

The problem of securing an efficient naval reserve has long been a subject of serious study abroad, particularly in Great Britain, where the question assumes special importance, owing to the manning of the fleet being there dependent upon voluntary enlistment. The measure now in force in the British navy requiring new reserve men to serve on board ships in commission for a sufficient time to give them some idea of naval duties will, it is believed, have good results.

MOBILIZATION.

The importance of rapid mobilization is fully appreciated in foreign navies. Some of them, profiting by the experience gained in the annual tests in connection with naval manœuvres, have reached a high degree of proficiency in this respect, as is demonstrated by the facility with which officers and crews go on board strange ships to be temporarily commissioned, assume their duties at once, enter promptly upon the service to be performed, and upon its completion lay up their ships and turn in their stores without delay. The prompt mobilization last year upon short notice of a British reserve fleet, including well-drilled flotillas of torpedo boat destroyers, in view of threatening foreign relations, afforded a notable example of the value of practice in such work.

NAVAL LEAGUES.

A movement in connection with naval matters which has received a remarkable impetus within the past few years in several maritime countries is the development of naval leagues—associations having for their chief aims the diffusion in popular form of information concerning the navy of the nation and advocacy of its maintenance and increase.

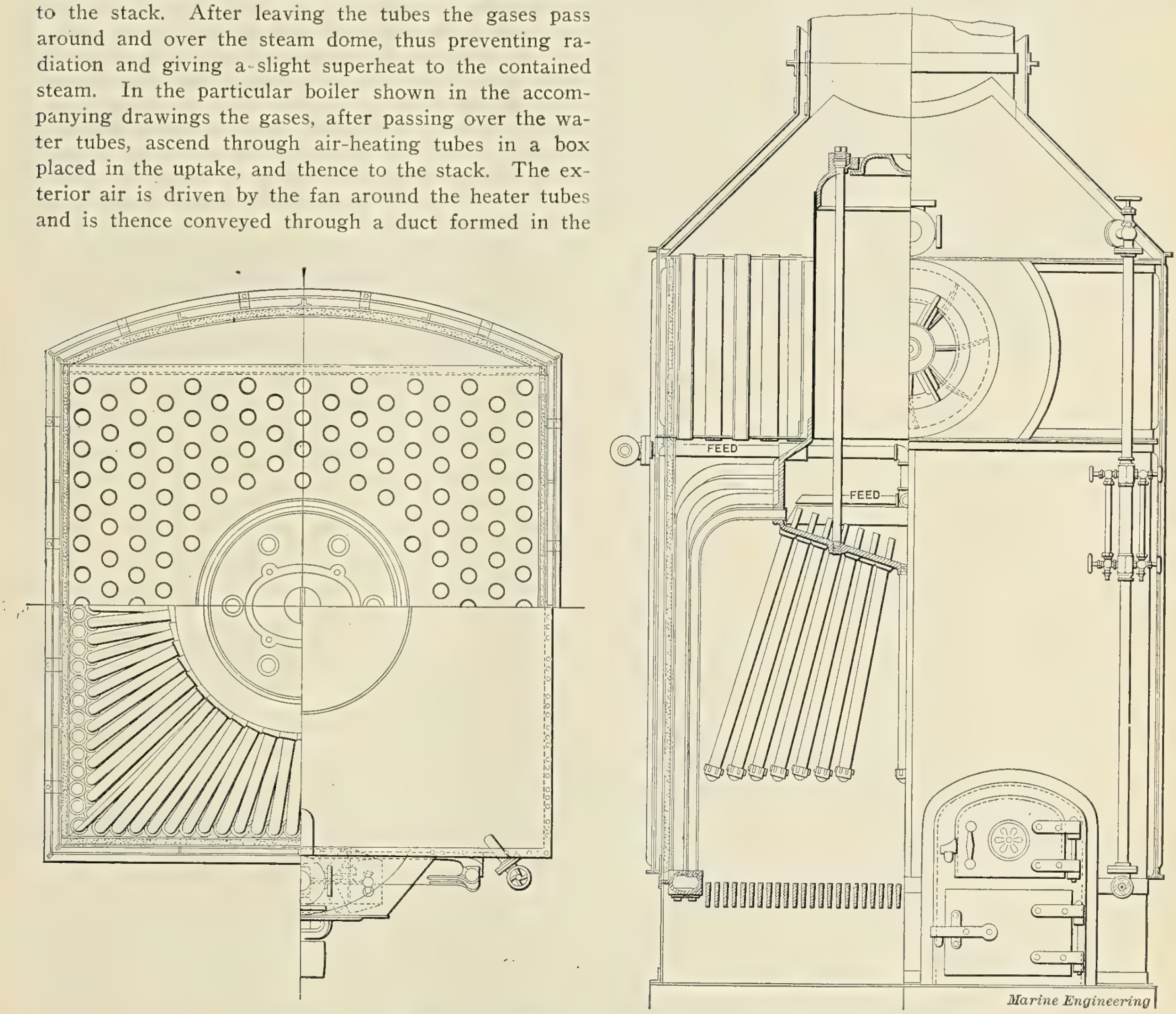
PIGEON POST.—Vessels of the French Line leaving New York recently have carried away carrier pigeons, which were released when the vessel had been out 24 to 48 hours. The pigeons belong to a cote in Malden, Mass. Messages from the ship's officers and passengers are reduced to a very small compass by the usual photographic process, and incased in a tiny aluminum tube, which is secured to the bird's leg before it is sent off. On a recent east-bound trip of the *Touraine*, her commander dispatched six birds when 300 miles out.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—VI.

Ward Water Tube Boiler.

This description of the Ward water tube boiler refers particularly to the type for small boats and vessels, such as are used almost exclusively in the steam launches of the U. S. Navy. Charles Ward, the inventor and builder, has designed water tube boilers of a variety of types, suiting the design to the special requirements of each case. Of the larger types of Ward boiler the best known, perhaps, is the coil boiler as fitted in the U. S. S. *Monterey*. The boiler here described differs from the navy launch type in that it is fitted with a self-contained system of forced draft, as will be readily seen upon inspection of the accompanying drawings. The type of boiler here described is built both square and round in plan view, that shown being the square boiler. It consists of a combination of plain bent water and straight Field tubes, with an upper central receiver and a lower manifold or base ring carried around the boiler at the grate level. The firebox is wholly composed of tubes, and no fire bricks are used in the boiler. The firebox is surrounded by a double wall of plain water tubes that rise vertically from the bottom manifold; and at their upper extremities are curved sharply inwards and are expanded into the central receiver. It will be noticed that the tubes rising from a square base enter a circular receiver, each one not radially, but at an angle peculiar to itself, as shown in the plan view. This necessitates very careful construction. The bottom of the central receiver, which forms the crown sheet of the furnace, is not flat, but an inverted cone. Into this are screwed the upper ends of the straight, pendant, Field tubes. They are arranged in concentric circles and project downward, at a slight angle to the vertical, into the combustion chamber. To insure a regular circulation in the Field tubes the upper end of each is closed by a diaphragm in which two tubes of smaller diameter are expended. One, for the downflow, extends from the diaphragm to within 1-2 in. of the bottom of the interior of the Field tube, and the other is a short tube which extends upward from the diaphragm and delivers the ebullition at a point well above the source of supply to the Field tube. Each Field tube is fitted at its lower end with a steel cap, threaded left hand, while the upper end, connecting with the central receiver, is threaded right hand. Thus in removing a bottom cap, with a wrench, the operation tends to tighten the tube in place, while if the tube is to be removed bodily the reverse rotation secures this result without fear of the cap coming away alone. The feed water is carried into the central receiver and is discharged through four radial pipes outside an annular metal ring which encircles the Field tubes and separates them from the outer water tubes. These four feed outlets are close to the upper ends of the inner row of bent water tubes (see drawing), and the feed supply therefore takes the shortest route down this inner row of tubes to the tubular base ring or manifold at the bottom, and from there ascends through the other rows of bent tubes to the central receiver again. The heating of the feed water in this manner causes all the foreign matter contained in it to be deposited in the

base ring, whence it can be blown out through suitable openings. Both the cone-shaped receiver and the base ring or manifold are steel castings with holes cored out and afterward accurately machined. Extending upward from the top of this central receiver, inside the casing, is the steam dome, the cover of which is secured to the bottom of the central receiver by long stay bolts. A manhole in the top of this dome gives ready access to the interior of the receiver. In operation the gases ascending from the fire meet the Field tubes and are broken up, before passing to the sides and over the horizontal ends of the bent water tubes on their way to the stack. After leaving the tubes the gases pass around and over the steam dome, thus preventing radiation and giving a slight superheat to the contained steam. In the particular boiler shown in the accompanying drawings the gases, after passing over the water tubes, ascend through air-heating tubes in a box placed in the uptake, and thence to the stack. The exterior air is driven by the fan around the heater tubes and is thence conveyed through a duct formed in the back casing to the under side of the grate. Airtight doors close the ash-pit in front, and the fire door frames are made hollow and are fitted with numerous nozzles through which air can be admitted above the fire to facilitate combustion. A double metal sectional casing is fitted around the entire boiler and is filled with nonconducting material, and outside of this again there is an air space within the outer casing, and which extends from the ash pan to the funnel. The boiler is patented and manufactured by Charles Ward, Charleston, Kanawha County, West Virginia.



SECTIONAL PLAN AND ELEVATION OF WARD WATER TUBE BOILER—SQUARE TYPE.

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—I.*

BY PROF. A. H. SABIN.

Ordinary oil paints consist of linseed oil, sometimes more or less adulterated, mixed by grinding with a pigment, which latter is usually a mineral substance reduced to a fine powder. The object of using a pigment, aside from its color, is threefold:

First. It hardens the film, which will thus better resist abrasion. Second. It makes it possible to apply a thicker film, which also wears longer. Third. The particles of pigment tend to fill up the pores which are naturally present in the oil film, and thus the porosity is reduced.

The pigments used for preservative paints are few in number as compared with those used in house or other decorative painting. They may be described briefly as follows:

White Lead.—This is a mixture of lead hydrate and

*From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies U. S. A.

carbonate, and is sometimes sold as a dry pigment; but more frequently as paste white lead, which is nine parts dry pigment ground with one part by weight of raw linseed oil. This may be made into a paint by thinning it with oil, and usually a little turpentine is also added. The object of the latter is not to cheapen it (indeed, at the present time turpentine is worth more than oil), but to make it work more freely under the brush and to increase the proportion of pigment in the film. This is a matter which it is very easy to overdo, and if too much turpentine is added there will not be enough oil to act as cementing material for the pigment, which will then be easily removed.

White lead is especially liable to suffer in this way, since it normally takes less oil than any other pigment, and, moveover, it seems to have a natural tendency to combine with the oil. This combination causes the oil to lose its coherence, and then the surface of the paint easily rubs off. As painters say, it chalks. No doubt a great deal of the bad name of white lead is due to this excessive and improper use of turpentine, which is liked by the painter also because it makes the paint much whiter than it is when oil is used, and because it dries rapidly, owing to the volatility of the turpentine.

White zinc is an oxide of zinc, white in color, and it requires more oil than white lead. It is less opaque; its opacity or covering capacity is usually estimated as three-fifths that of white lead. Paint made with it does not readily brush off as a powder, but sometimes seems to come off in flakes. Painters say it peels or scales. It is commonly used mixed with white lead, and the mixture seems to be better than either substance alone. Paints made with these pigments are frequently, perhaps it may be said commonly, adulterated with other white powdered substances, such as kaolin and barytes, which are not particularly harmful, and whiting or carbonate of lime, which is actively injurious. While dry these substances appear white, but when mixed with oil they seem to be transparent. They are without value as pigments, and must be regarded as adulterants.

White lead and white zinc are practically the only white pigments, and must form the basis of all light-colored paints. Other light colors are made by adding some tinting material to them. The principal yellow color is chromate of lead, or chrome yellow. This is a very brilliant color, rather deep in shade, and the pale shades are made by adding white lead. Chrome green is a mixture of chrome yellow and Prussian blue, and is the only green pigment in common use. Prussian blue is a ferrocyanide of iron, dark blue in color. The common light blue pigment is ultramarine blue, an artificial product of complex constitution, the exact composition and preparation of which is a secret. The yellows, greens and blues are not much used in paints for structural work, but this is not the case with red pigments, the most important of which are the oxides of iron. For this purpose the sesquioxide, which is known in mineralogy as hematite, and the hydrated sesquioxide, or limonite, are used. Usually the two are mixed together in various proportions, the pigment being produced by grinding a natural oxide rock, which commonly contains from 10 to 60 per cent. of other mineral matter, commonly silicates. The color of these oxides varies from bright red to dark brown, the bright shades commonly containing most hydrated oxide and the brown (rarely dark purple) shades being chiefly anhydrous; oxides of a bright purple or maroon tint are, however, hydrated. It is commonly believed that the brown or dark red shades, that is, the anhydrous oxides, are more durable than the others. Some of these oxides are of artificial origin, such as Venetian red, which is a by-product, originally containing some sulphuric acid, to neutralize which it has been saturated with lime; and in consequence the finished pigment contains a large percentage of sulphate of lime, which cannot be regarded as a desirable ingredient. A knowledge of the chemical constituents of an oxide pigment is therefore desirable. A considerable proportion of silica, or of highly acid silicates, is probably not objectionable, especially if the product is nearly anhydrous; but if there is ground for believing that the silicates themselves are hydrated, they are simply clay, which is objectionable; and if any lime-salts, soluble in water or acid, are present, the material is not suited for the purpose.

Oxide pigments are particularly open to the criticism of being, in many cases, not finely ground, a most serious objection. Any good paint should be so fine that it feels smooth and even when rubbed on glass or porcelain with a palette knife. The importance of fine grinding is not likely to be overestimated. Ochres, umber and sienna are also classed with the iron oxide pigments, and usually contain a little manganese, which increases the drying qualities of the oil. They also contain various earthy coloring matters. The ochres are yellow in color, and the iron oxide in them is hydrated. They are often used in conjunction with white lead or zinc.

Carbon, in one form or another, is the base of all the black pigments. By far the most common of these, as used in structural paints, is graphite. Other black pigments are lamp black (including carbon black) and bone black, the former being produced in many grades, varying in price from 3 or 4 cents to 60 cents per pound. Bone black, which is refuse from the sugar-house black, varies in the percentage of carbon contained, which is usually about 10 or 12 per cent., the remainder being the mineral matter originally present in the bone and containing 3 or 4 per cent. of carbonate, while most of the remainder is phosphate of lime. Lamp black is an absolutely impalpable powder, which has a small amount of oily matter in it, and greatly retards the drying of the oil with which it may be mixed. For this reason it is not used by itself, but is added in small quantity to other paints, which it affects by changing their color and probably their durability. For example, it is a common practice to add it to red lead in order to tone down its brilliant color and also to correct the tendency it has to turn white, due to the conversion of the red oxide of lead into the carbonate.

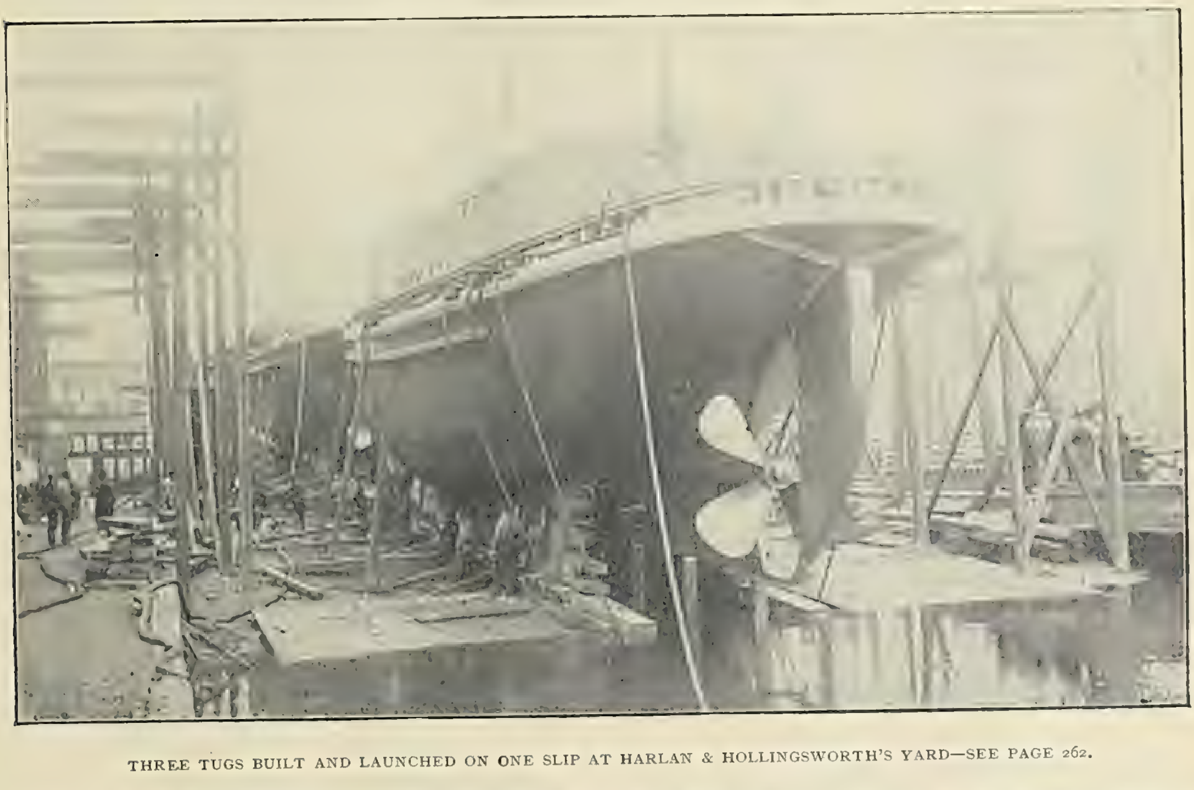
S. Y. Saghaya.—A new steam yacht for Charles Stewart Smith and his son, H. C. Smith, was launched from the Morris Heights (N. Y.) yard, May 24. The yacht measures: Length over all, 127 ft.; on water line, 103 ft.; beam, 15 ft. 6 in.; draft, 6 ft. 6 in. She is of composite construction, and is fitted with triple expansion engine and boiler, which will give her speed of about 16 miles an hour.

New Harvard Coaching Launch.

A new launch, to be used in coaching the boat crews of Harvard University, was built recently at the yard of

NEW 50-FT. COACHING LAUNCH FOR ROWING CLUB OF HARVARD UNIVERSITY, BOSTON, MASS.

George Lawley & Son, South Boston, Mass. The new launch, built to replace one which we understand was accidentally destroyed by fire, is named the *John Har-*



THREE TUGS BUILT AND LAUNCHED ON ONE SLIP AT HARLAN & HOLLINGSWORTH'S YARD—SEE PAGE 262.

vard, and is of these dimensions: Length over all, 51 ft. 3 in.; length on water line, 50 ft.; beam, 7 ft. 8 in.; maximum draft, 3 ft. She is a double end, shoal draft launch, built with oak frames, white cedar planking, mahogany deck, washboard, and seats.

The launch is divided into three compartments by steel bulkheads forward and aft of the machinery space. In a fore and aft direction the cockpit takes up 34 ft., the machinery space 13 ft., forward standing room 11 ft., and after standing room 10 ft. The propelling engine is of the regular vertical, inverted triple expansion type, with cylinders 4 1-2 in., 7 in., and 12 in. dia., and

7 in. stroke. Steam is generated in a water tube boiler having 11 sq. ft. of grate surface. A condenser of the outside keel type is fitted, and inboard there is an independent air pump 4 in. and 4 in. by 5 in., and a duplex boiler feed pump 3 in. and 2 in. by 3 in. Tobin bronze is used for the propeller shaft, which carries a four-bladed screw 30 in. dia. and 40 in. pitch. The smokestack is double, with a brass outer shell, and is hinged so as to permit the launch to pass under low bridges. On trial a maximum speed of 16 miles an hour was attained with 525 engine revolutions.

Triple Launching at Wilmington.

It is rare that a triple launching takes place in a yard, and rarer still, perhaps, that the three vessels launched are slid off one set of ways. This was the case, however, at the yard of Harlan & Hollingsworth, Wilmington, Del., May 12, when the steel tugs *Wilmington, Harrisburg,* and *Johnstown* were sent into the water one after the other within the space of a very few minutes. The tugs, built for the Pennsylvania Railroad, are of these dimensions: Length, 100 ft.; beam, 22 ft.; depth, 12 ft. 2 in.; displacement, about 230 tons. A photograph of the little vessels, taken just before the launching, is here published. The boats were launched about ten o'clock in the morning, advantage being taken of a high tide. In little more than a quarter of an hour after the wedges were set up on the first tug, the last had taken the water gracefully.

The propelling machinery consists of a compound engine with cylinders 20 in. and 40 in. dia. and 26 in. stroke. Steam is furnished by two Almy water tube boilers.

Work in the Harlan & Hollingsworth yard is at present very brisk. On the ways occupied by the tugs, the new 400 ft. steamship for the Mallory Line will be laid down. Other work in the yard includes the destroyers *Hopkins* and *Hull,* a steamer for the Metropolitan S. S. Co., a steam yacht for Charles Fletcher, of Providence, R. I.; three barges for the Rockland Line Co., two steamers for the Philadelphia Steamship Co., and the reconstruction of the steamships *Foxall* and *Indiana*—the latter being lengthened 40 ft.

T. S. S. La Savoie.—The second of the two new mail steamships for the French Line, New York to Havre, was launched March 31 at St. Nazaire. The launching was an important function at which the French Minister of Marine presided. Like her sister ship, the *La Lorraine,* the *La Savoie* is built under the stipulations of the new mail contract entered into by the company with the French Government. Both these vessels were described in detail in our issue of January last, but it is well to recall the dimensions, which are: Length over all, 580 ft.; beam, 60 ft.; depth, 39 ft. 6 in.; displacement, at mean draft of 25 ft. 3 in., 15,200 tons. On six hours trial the vessel is expected to attain 22 knots speed. She will have accommodations for about 1,000 passengers of all classes, and will carry a crew of nearly 400 all told. The propelling engines will be of the four cylinder, triple expansion type, and single ended Scotch boilers will be fitted. She will be fitted out so as to be capable of receiving a considerable armament of rapid fire guns when needed as an auxiliary cruiser.

LAUNCHES—HOME AND FOREIGN.

S. S. Californian.—This large steamship for the new American-Hawaiian line was launched at the Union Iron Works, San Francisco, May 12. She is of these dimensions: Length, 430 feet.; beam, 50 ft.; depth, at center, 34 ft. 6 in.; draft, 26 ft. She is constructed in accordance with Lloyd's 3-deck rules. Triple-expansion engines will be fitted with cylinders, 27 in., 45 1-2 in., and 76 in. by 48 in. stroke, capable of developing 2,500 I.H.P. Steam will be supplied by four single-ended Scotch boilers. With 8,250 tons dead weight a mean speed of about 10 knots will be maintained at sea. The bunker capacity is 1,500 tons. This is the largest vessel ever built on the Pacific coast. Two similar ships are now under construction at the Roach yards, Chester, Pa. The *Californian* was launched by moonlight between 10 and 11 P. M. Miss Edith Chesebrough, daughter of the vice-president of the owning corporation, broke the customary bottle of wine.

U. S. S. Thornton.—At the Trigg yard, Richmond, Va., the U. S. torpedo boat *Thornton* was launched May 15. The ceremony of christening the new boat was performed by Miss Mary Thornton Davis, grandniece of Captain J. S. Thornton, U. S. N., who was executive officer of Admiral Farragut's flagship at the battle of Mobile Bay, and was mentioned in despatches. The *Thornton* is one of the group of boats authorized by Act of Congress of May 4, 1898. A contract for her construction was signed November 16, 1898, and her keel was laid March 16, 1899. Her dimensions are: Length, 175 ft.; beam, 17 ft. 6 in.; mean draft, 4 ft. 8 in.; displacement, 165 tons. She is to be fitted with twin screws and quadruple expansion engines, and Thornycroft boilers. The estimated trial I.H.P. is 3,000 and the speed 26 knots.

S. S. Tampico.—A steamship designed for service on both the Great Lakes and the ocean was launched at the Craig yard, Toledo, last month. She is of these dimensions: Length, 250 ft.; beam, 42 ft.; depth, 25 ft. Her propelling engines are of the triple expansion type, with cylinders, 19 in., 30 in., and 52 in. dia., and 40 in. stroke. Steam is supplied by single-ended Scotch boilers, 12 1-2 ft. dia and 11 1-2 ft. long. The vessel is built upon the lake model, with the machinery at the extreme after end, but with this difference that the pilot house, instead of being well forward, is located about amidships. Her construction is very strong, and it is expected that in the winter season she will be able to successfully operate on the Atlantic coast, passing through the St. Lawrence Canal on her way.

T. S. S. Minnehaha.—Another monster vessel for the Atlantic Transport Co. was launched at Belfast, Ireland, March 1. She is named the *Minnehaha,* and is of these dimensions: Length, 600 ft.; beam, 65 ft.; depth, 44 ft.; gross tonnage, 13,750 tons. She is fitted with twin screws driven by quadruple expansion engines, with cylinders 30 in., 43 in., 63 in. and 89 in. by 60 in. stroke. Like the other vessels of the fleet she will carry only cabin passengers. Besides the large freight capacity there will be accommodation for many head of cattle.

S. S. Isaac C. Elwood.—A large lake freighter, the *Isaac C. Elwood*, was launched from the Bay City yard of the American Shipbuilding Co., May 5. This vessel was built for the American Steel & Wire Co.'s interests, and is the third of the 500 ft. fleet, the others previously launched being the *John W. Gates* and the *J. J. Hill*. The dimensions of this type of vessel are: Length, over all, 500 ft.; beam, 52 ft.; depth, 30 ft. The estimated carrying capacity is 8,000 tons, on a draft of 18 ft. These vessels are equipped with quadruple expansion engines, water tube boilers, automatic stokers, and a complete outfit of auxiliaries and deck appliances. Another vessel of the same dimensions will probably be launched from the same yard this month.

S. S. G. W. Dickinson.—A new steamer built for the Pacific Clipper line to enter the Cape Nome and Alaska trade, was launched by Moran Bros., Seattle, Wash., April 16. This is the largest wooden vessel ever built in Seattle, measuring about 215 ft. in length and 1,200 tons gross tonnage. She was built to carry passengers as well as freight, and has accommodations for about 300 in her cabins. She is fitted with engines capable of giving the vessel a speed of about 10 knots. It is understood that this boat will be purchased by the Government for service in the Army transport department. The steamer is reported to have cost about $140,000.

Tug John K. Cowen.—At the yard of the Spedden Shipbuilding Co., Baltimore, Md.. the tug *John K. Cowen* was launched April 19. The tug is built of steel and is to the order of the Baltimore & Ohio Railroad. Her dimensions are: Length, 110 ft.; beam, 22 ft.; depth, 13 ft. The machinery will be capable of giving the tug a speed of 14 miles when running free. The machinery will be fitted by the Neafie & Levy S. & E. B. Co. of Philadelphia. Another tug of about the same dimensions was laid down on the slip from which the *Cowen* was launched.

S. Y. Margarita.—The Watson-designed full-powered steam yacht *Margarita*, for A. J. Drexel of Philadelphia, was launched at the Scott yard, Greenock on the Clyde, April 30. This vessel was described in our issue of February last. Her dimensions are: Length, over all, 323 ft.; beam, extreme, 36 ft. 7 in.; load draft, 16 ft. 8 in. She will have twin screws, triple expansion engines, and a trial speed of about 17 knots. Her cost is said to be not less than $750,000.

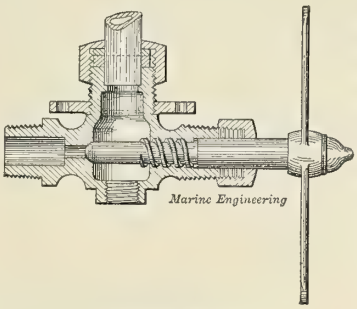
S. S. Robert W. E. Bunsen.—At the yard of the Chicago Shipbuilding Co., South Chicago, this addition to the Bessemer fleet was launched May 15. The new vessel is of the regular lake type of ore carrier and is of these dimensions: Length, 460 ft.; beam, 55 ft.; depth, 29 ft. She will carry 7,500 tons of ore on 18 ft. draft.

Barge Georgia.—A coal barge with a capacity of 3,000 tons for the Coastwise Steamship Co., of New York, was launched at the New England Shipyard, Bath, Me., April 30. The barge is built of wood, and is fitted with steam auxiliaries, including Hyde windlass and wrecking pumps.

Sch. Bainbridge.—A 4-masted wooden schooner for the Pacific coast lumber trade was launched at Hall Bros.' yard, Port Blakely, in May. The new vessel has a capacity of 800,000 ft.

IMPROVED APPARATUS.

Quick-closing Water Gauge.



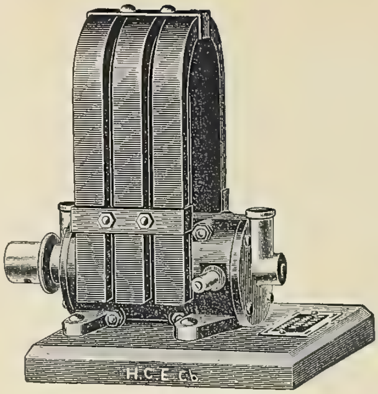
SECTION OF COCK.

An improved form of safety gauge glass mounting is shown in the sectional engraving of the "P. B. H." quick-closing water gauge. The glass is carried in the usual way in large stuffing boxes with screw glands. The cocks which control the steam and water inlets to the glass pass through stuffing boxes in the front of the water gauge, and are fitted with T handles. The ends of each handle, top and bottom, are connected by a chain, which is carried down sufficiently low so that it can be easily reached by the fireman. These cocks are fitted with solid plugs, the inside ends being rounded and seating in the passage between the glass and the boiler or water column. The plugs are threaded with a quick square thread, so that a very slight movement of the outside arm is sufficient to fully open or close the outlets. As the ends of the chains are hooked into the ends of the plug handles and the chain looped down, the cocks can be opened or closed separately or together, as desired. There is no automatic device about this gauge such as is often depended upon to act in emergency and fails to do so. It is positive in its action, and being constantly operated while a boiler is working, it is always in good condition and ready for an emergency. In case of failure of a glass the steam and water can be cut off almost instantly, and a glass replaced without any delay while a full head of steam is on. The new style gauge is manufactured by Paul B. Huyette, 1225 Betz Building, Philadelphia.

Gas Engine Igniter.

In motor boats trouble is often experienced with the batteries used to produce the igniting spark in the engine. To obviate this the Holtzer-Cabot gas engine igniter has been designed. The machine is constructed with a permanent magnet field and an armature of the drum type, similar to that used in direct current motors. It has self-feeding carbon brushes, and is self-lubricating, being provided with grease cups. This igniter is especially adapted for marine work; the armature, being enclosed, is dirt, oil, and moisture proof. It can be run in either direction, and if the fly wheel of the engine runs true, the igniter may be driven from a friction pulley bearing upon the wheel, or may be belted to the fly wheel or to any convenient shafting. The speed should be about 2,000 revolutions, but it can be run at any speed, from 1,500 to 2,000 R. P. M. A battery, consisting of four or five cells of any ordinary circuit form, is used, but for a few minutes, merely to start up the engine, and will consequently last indefinitely. In addition to a spark coil which must be placed in circuit

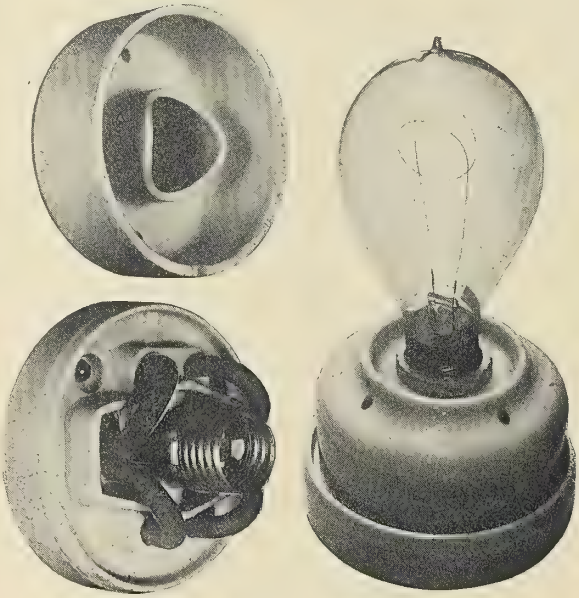
with the igniter, the use of the automatic switch is recommended for cutting the dynamo into circuit when it has reached a sufficient speed or voltage to produce a good spark. An ordinary two-point switch should be included in the battery circuit to prevent leakage in case the contacts in the engine cylinder remain closed when the engine is shut down. A similar igniter is also made under the name of the "automobile type," which measures only 7 1-2 in. high, 4 in. wide, 7 in. long. These igniters are manufactured by the Holtzer-Cabot Electric Co., Brookline, Mass.



HOLTZER-CABOT IGNITER.

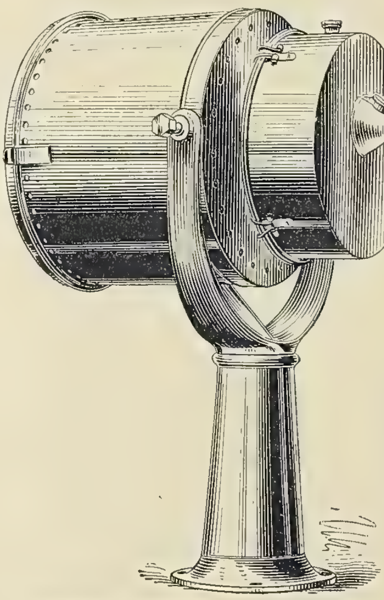
Neptune Marine Receptacle.

Any one who has had experience with ship lighting is familiar with the fact that water, that great enemy of electrical apparatus, will put in an appearance at the most unlooked for places. It frequently happens that a vessel will ship a big sea, or a bath tub will run over; in fact water will find a passage in a multiplicity of ways into the grooves in which the electric conductors are located. Lamp fittings being attached to the ends of the wires always form the outlets for the stray water and are invariably destroyed if they are not of the watertight type. Heretofore watertight electric fittings have always been made of metal with a watertight glove, and the ingress of water has been prevented by means of watertight stuffing boxes, using soft rubber bushings. Such lamp fittings cannot be used exclusively on a ship on account of their great cost and their unsightliness, and so as a rule have been applied only in the engine room and fire room. The Neptune waterproof receptacle here illustrated is built upon a new principle, inasmuch as it is not a watertight fitting, but a waterproof device, and cannot be injured thereby, even if the water should run into the interior of the receptacle. The water is shed before it can reach any of the vital parts, which are the metallic connections. Thus short circuits and deterioration are absolutely prevented. The principle of the device to accomplish this result is very simple. It consists in arranging the interior so that the water will run off in a bight or loop of the conductors through holes provided in the cap. The base and cap also have suitable barriers and bosses to help bring about the above result. This new device is manufactured by the Electro Dynamic Co., 224 Ionic St., Philadelphia, Pa.


NEPTUNE MARINE RECEPTACLE.

Baldwin Acetylene Searchlight.

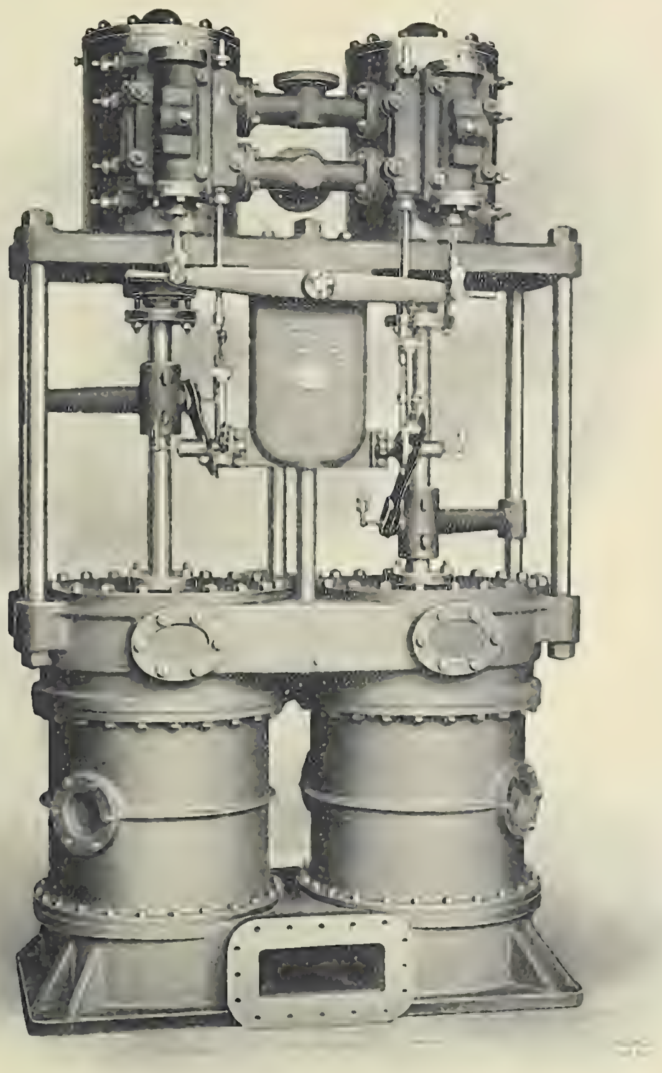
The Baldwin acetylene searchlight is a compact, self-contained form of projector designed especially for use in small yachts and launches. It is very simple in its mechanism, and is manufactured in tasteful style, so that it is a very sightly addition to the equipment of a small vessel. It is self-contained in the strict sense of the term, as no extra tank or generator is necessary, and as it is all in the open air there is no possibility of any escape of gas in the living quarters. The total height of the lamp is 16 in., the reflector being 8 in. dia. In small launches it is placed in the bow, and is operated by a handle on the back. For cabin launches or yachts an extra attachment is made, so that the lamp can be controlled by one hand only. The cost of operation is stated to be very small, and the light is sufficiently powerful so that objects can be picked up at


BALDWIN ACETYLENE SEARCHLIGHT.

a distance of several hundred feet. This searchlight is made by A. H. Funke, 101 Duane St., New York City.

Independent Air Pump.

The engraving herewith shows Dean Brothers' Twin Cylinder Air Pump with patent steam valve gear. This mechanism so controls the pistons that they will always move synchronously in opposite directions and invariably work to the full limit of their stroke. Should one piston move faster than the other, and therefore reach the limit of its stroke in advance of the other it will wait until the second piston reaches the opposite limit of its stroke, when both pistons will simultaneously reverse their motion. The necessity of a beam connecting the two piston rods is obviated, and the friction of the beam and its numerous connections avoided. Where a beam is used there must be cross heads, slides, pins, joints and other complications that not only produce friction but are also in danger of breaking or derangement. Dean Brothers' twin cylinder air pump may be operated in three ways. (1) The two pumps may be operated in conjunction as above stated. (2) By detaching the lever that connects the chest pistons the pumps may be run independently. (3) By disconnecting both the chest piston lever and the steam valve rod of one pump its operation will be stopped while the other pump will continue to operate. If from any cause one pump is disabled the other one may be run until repairs can be made. This is the only twin cylinder air pump made that is convertible into separate pumps. The marine engineer will appreciate this feature, as the stoppage of an air pump at sea is a serious matter. The piston rods are separable at the cross heads. The cross heads are of steel. The steam cylinders and pump cylinders are connected by six heavy steel stretcher rods. Adjusting valves are fitted to steam cylinders for controlling the motion of the pistons. The valve gear is provided with patent lever adjustment, by which the length of stroke of pistons may at any time be changed, even while the pump is running. This style of pump is manufactured by Dean Bros.' Steam Pump Works, Indianapolis, Ind.



DEAN TWIN CYLINDER INDEPENDENT AIR PUMPS.

MARINE ENGINEERING

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MANY and conflicting rumors concerning a probable seismic disturbance in the construction departments of the British Navy have been in circulation lately. It is said with some pretense of authority that the Director of Naval Construction, Sir William H. White, will resign, as he is not in accord with other chiefs regarding designs for new vessels, and for the further reason that he feels keenly the responsibility for the botched construction of the Queen's yacht. The reason first given is the more plausible, for —if there is any foundation at all for the rumor— the matter of a mistake in calculations, made no doubt by a subordinate, would hardly be likely to cause the resignation of so able a chief constructor. Mistakes will occur in shipbuilding just the same as in other industries—not simply errors of judgment or failure of careful design to give results expected, but gross errors that are inexcusable—errors in simple addition, possibly. Elsewhere in this issue we report a case tried before the House of Lords in which errors in calculation made by a draftsman for an eminent firm of shipbuilders have cost his employers the large sum of $80,000. But to return to the British Navy. Rumor extends the area of upheaval to the Department of Steam Engineering, of which Engineer-in-Chief Sir Albert J. Durston is the head. The well informed *Pall Mall Gazette* gives voice to the rumor in its issue of May 9 last as follows:

> We have reason to believe that an important change is impending in the policy of the Admiralty on the boilering of the ships of the Royal Navy. We have argued for a long time past, on the evidence that was collected in the columns of the *Pall Mall Gazette* early last year, that the wholesale adoption of Belleville boilers for our battleships and cruisers was a grave error of judgment. Experience has proved that this contention was at least well founded, and we believe that the Lords of the Admiralty have at last recognized this. Their conversion has been assisted not a little by the record of the *Powerful*, which crept home from the Cape at less than half her designed speed, and will now have to be practically eviscerated before she can be recommissioned for service.
>
> If, as we are given to understand, the Admiralty are now convinced that it would be dangerous to rely on this type of boiler in time of war for other than torpedo craft, the naval service will welcome the fact with immense relief. But the change of policy involved will necessarily cause the Lords of the Admiralty to revise the personnel of the consultative engineering branch. Several important changes are, we believe, in contemplation, and with them it may be expected that a reform vitally affecting the efficiency of the Fleet will be commenced immediately. As a preliminary, it would be desirable that a committee of experts should at once be appointed to examine the whole boiler question.

From this it would seem that the boiler fight which waged with extraordinary fierceness across the water some years ago might be reopened. It is not likely that the advocates of the water tube boiler will allow any return to the older tank boiler, though at the same time it is not unlikely that influences are at work to discredit the Belleville boiler and substitute for it some form of water tube boiler native to the soil. The authority quoted above is manifestly in favor of the tank boiler, as it says: "The Admiralty are now convinced that it would be dangerous to rely on this type of boiler in time of war for other than torpedo craft." As the Belleville is, of course, not used in torpedo boats, the reference to "type" must mean the water tube type in all its forms. The proposition, therefore, that the water tube boiler cannot be relied upon in time of war, and by inference that it can be relied upon in time of peace, is a novel one. It is, we believe, generally held that one of the chief advantages of the water tube type is its adaptability to war conditions. Our own Engineer-in-Chief, George W. Melville, in his splendidly practical paper on the subject, read before the last meeting of the So-

ciety of Naval Architects and Marine Engineers, gives as chief among the reasons for the adoption of the water tube boiler in the United States Navy that "water tube boilers give tactical advantage of great movement." He cannot be called a biased advocate of this type of boiler, for he recognizes its disadvantages, but shows that these may be neutralized in "selection, manufacture and management." So far from being an opponent of the tank boiler, he says: "It is at best a moot question whether cylindrical boilers are not still the best that can be fitted in ocean-going merchantmen." With the great experience which our Engineer-in-Chief has had with widely differing types of water tube boilers in the Navy to assist in forming his judgment, and with the entire absence of prejudice where the tank boiler is concerned, it would need some argument more convincing than the failure of the *Powerful* to reach expectations to cause designers to decide against the adoption of water tube boilers for naval vessels. As a matter of fact, it has always seemed as though the British were not as skilful in boiler as in engine construction and maintenance. This has been so notoriously in the British Navy. The merchant marine is another story. Repeated failures of cylindrical boilers in British war vessels greatly hastened the adoption of the water tube boiler, the Belleville being championed by Sir A. J. Durston, and fitted in a large number of the finest ships in her navy. One of the reasons (and probably the correct one) given for the failure of the cylindrical boiler was that many of the older ships of the British Navy were underboilered, and in those days forced draft was not as well understood as now. At one time, indeed, leaky tubes in the back connections threatened disaster to the British fleets and thus caused the adoption of the famous "Admiralty ferrule." The troubles in the British Navy did not end with the adoption of the water tube boiler for the larger vessels. The earlier boilers of the Belleville type were not fitted with economizers, and the coal consumption figures were high, and then a more direct cause of alarm was the frequent failures of lap-welded water tubes, with, in some instances, attendant loss of life. Since the introduction of the economizer and the solid drawn steel tube it was generally supposed that a satisfactory solution of the trouble had been reached. Apparently not, and the next move will be watched with the very greatest interest by the entire marine engineering world.

A MEMORANDUM of the chief characteristics of the three sea-going coast line battleships for the Navy, authorized by act of Congress of March 3, 1899, has been issued. It will be recalled that the act providing for the construction of these ships placed such restrictions upon the matter of armor plate to be provided for them that, as a consequence, contracts for the vessels could not be let, and the situation will so remain until Congress shall settle the armor plate dispute. This delay has been taken advantage of by the Bureau of Construction to carry out model experiments for the proposed battleships, the new tank at the Washington navy yard being utilized for the first time in such work. The designs are thus very well thought out, and the only question of structural detail yet not finally settled is that of the arrangement of the main battery. Advocates of the superimposed turrets, as employed in the *Kearsarge* and the *Kentucky*, have insisted that the new vessels be similarly equipped. A majority of the Board of Construction, however, with very commendable conservatism, agreed upon the more usual form of arrangement of battery, leaving a clause in the circular that permits the adoption later of the superimposed system if it is considered advisable. Considering that the system, as adopted in the case of the *Kearsarge* and the *Kentucky*, is an absolute novelty and has simply had a few acceptance tests, as it were, and no extended trial under service conditions, it seems as though the premature and wholesale adoption of the system would be a grave mistake. The new ships will be named the *Pennsylvania*, the *New Jersey*, and the *Georgia*, and will be of these dimensions: Length on load line, 435 ft.; beam extreme, 76 ft.; trial displacement, 14,650 tons; mean draft at trial displacement, about 24 ft.; maximum draft, fully loaded, about 26 ft.; total bunker capacity, 1,900 tons; coal carried on trial, 900 tons; feed water on trial, 66 tons; speed not less than 19 knots. The armament will include four 12-in. breech loading rifles, eight 8-in. ditto, twelve 6-in. rapid-fire rifles, twelve 14-pdrs., twelve 3-pdrs., four 1-pdrs., all of the rapid-fire type, and also two 3-in. field pieces, two machine and thirty automatic guns. The propelling engines will be of the four cylinder, triple expansion type of 19,000 collective horse power. Water tube boilers will be installed, arranged in groups, each group in a water-tight compartment. The armor protection will include a complete belt at the water line of a maximum thickness of 11 in.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—I.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

In the present section it is the purpose to give brief hints and suggestions regarding the routine of operations in the fireroom in getting under way and on the voyage, supposing that everything is working smoothly and without trouble. We shall first suppose that fire-tube boilers are in use, and later give such supplementary suggestions as may be suitable for water-tube boilers.

A general examination must first be made of the boiler and fireroom equipment in order to make sure that everything is in readiness for getting up steam. Among the more important points to be attended to the following may be mentioned:

See that the coal bunker doors are in proper working order and if the bunker is partly empty it may be well to air it by opening the door and taking off the deck plates.

See that the coal handling gear is on hand and in proper condition.

See that the necessary fire tools are provided, and distributed as needed.

Examine the grate-bars; bridge-walls and back-connections, and note whether the area of passage above the bridge-walls is properly proportioned. For usual conditions it should be from 1-5 to 1-7 the grate area.

Note the condition of the tubes both from the front and back connections.

Examine the dampers in uptakes and funnel to see if they are in working order, and open them preparatory to lighting the fires.

Examine carefully all valves, cocks, piping and connections and make sure that everything is connected up as it should be, and that no valves are open which should be closed nor closed which should be open.

See that no waste or other inflammable substances have been left about by workmen on the tops of the boilers.

If the water has not been previously run up in the boilers, this may be under way in the meantime. In modern practice the boilers are always filled with fresh water where possible, obtained from a hydrant on the dock or water boat alongside, and put in usually by a hose through an upper manhole. If, however, the boat is lying in fresh water, or if by necessity the water is to be taken from over board, it is then run in through the bottom blow and Kingston valve. In the meantime examine the connections leading to the water-gauge and cocks. Clean the glass if necessary, and make sure by means of a wire that the opening through the cocks is clear. The packing of the gauge glass should also be examined and renewed if necessary. When the water appears in the gauge glass and shows from one-half to two-thirds full in each boiler, it may be shut off.

All open manholes may then be closed, and the boilers are ready for the fires.

Notice of the time when steam is required should have been given not less than from six to eight hours in advance, and many engineers prefer a still longer time in which to bring along everything into working condition. With hard coal a certain amount of wood is necessary in starting the fires. With soft coal less wood is required, and if necessary oily waste may be made to answer the purpose. If fires are up in the donkey boiler a little live coal may be taken from them to assist in starting. As soon as the fires are going the hydrokineters are put on if such appliances are fitted. In some cases arrangements are made for drawing the water by the donkey or auxiliary feed-pump from the bottom of the boiler by the bottom blow and returning it through the feed-pipe, thus producing a forced or assisted circulation. Where there are no appliances for forcing the circulation during this period, it is considered good practice to light first the fires in the center furnaces, and later, by one or two hours, those in the wing furnaces. The natural circulation thus produced will more nearly even up the temperature within the boiler than if all fires are lighted at the same time. After the fires are fairly going the funnel or uptake dampers may be partly closed so as to hold the fires back, and bring them along at a moderate gait as desired.

While the boilers are thus warming up and before steam has formed, a last look may be given to the boiler mountings and their connections. The various cocks and valves should be worked, and especially the stop and safety valves, in order to make sure that none are jammed or in any way out of order. The oil lamps for the steam and water gauges may also be trimmed and lighted, or the electric bulbs cleaned, if such are provided.

During this period the steam-pipe drains and safety valves are usually open to allow of the escape of the air and of the condensed vapor as formed. In some cases, however, the safety valves are closed, and the stop valves being open, the air and vapor are expelled along the steam-pipe and through the engine, thus beginning the process of warming up. Many engineers, however, prefer to keep the boiler stop valves closed until steam is formed, and to discharge the air through the safety valve, or in some cases through a specially fitted air-cock. If steam is already up on some of the boilers or if there is no auxiliary steam-pipe and the pressure from the donkey boiler is on the main steam-pipe, then of course the stop valves must be closed on the boilers in which steam is being raised, and they must remain closed until the pressure on the boiler is equal to that in the steam-pipe. In opening a boiler stop valve connecting with a pipe in which there is no pressure the following precautions should be taken:

(1) The pipe should be thoroughly drained and especial care should be taken that there are no sags, bends or U's unprovided with proper drains, and in which a pocket of water may have collected.

(2) The valve should be very carefully eased from its seat and opened only from a quarter to a half turn until the pipe is under full boiler pressure and has taken the temperature of the steam, and the drains are discharging steam instead of water. In opening a boiler stop valve connecting with a pipe in which there is approximately the same pressure as in the boiler, it is simply necessary to ease the valve from the seat and note by the sound whether there is a sufficient differ-

ence of pressure to cause any violent flow in one direction or the other. As soon as the absence of such evidence indicates an equality of pressure on both sides of the valve, it may be opened out as desired.

The two fundamental principles underlying much of this routine and detail are simply as follows:

(1) To prevent as far as possible *sudden* changes in the temperature condition of the boilers, piping and machinery, and

(2) To prevent throughout the steam-pipe system the accumulation of water at any point.

If these two points are kept clearly in view and good engineering judgment used in carrying them out, the life of the boilers and machinery will be prolonged, and danger of ruptured pipes through the effects of water hammer will be avoided.

After steam is formed and the pressure has risen to some 40 or 50 lb. the hydrokineters may be shut off, especially if the ship is to get under way as soon as ready. If, however, the boilers are to stand some time with steam up, it may be advisable to turn on the hydrokineters from time to time, at least as long as the pressure in the donkey boiler is sufficient for the purpose.

The fires in the meantime have been kept simply in good condition without forcing, and even if they work under a forced draft system, only enough air should be provided during this stage to bring them along at the gradual pace which will allow the boiler to properly accommodate itself to the change in temperature and other conditions.

The fire-room auxiliary machinery should also be examined during this period, and tested under steam from the donkey boiler if possible. The feed pumps should first receive attention, in order that there may be no question as to the proper supply of feed-water when required.

The fan engines should be examined, oiled and turned over under steam.

The ash-hoist gear and engine, or ash ejector and pump, should be examined and put in working order.

If steam for these purposes is not to be had from the donkey boiler, then as soon as a sufficient head is formed on the main boilers these auxiliaries must be examined, taking in all cases the feed pump first.

Soon after lighting fires it may be desirable to slacken up somewhat on the funnel guys on deck, in order that the expansion of the funnel may not bring an undue stress upon the guys and their connections, or upon the funnel and its supports. After the ship is away and the funnel has taken its temperature for running conditions, the guys may be tightened up so as to properly support the funnel in a sea way.

At length we may suppose that full head of steam has been formed on the boilers, that the fires have been brought up to proper condition, and that the ship has gotten under way for the voyage. As soon as possible the operations in the fireroom should be brought to a regular routine. This will involve the following chief features, which we shall consider separately: (1) Firing. (2) Water tending. (3) Disposal of ashes. (4) Cleaning fires. (5) Sweeping tubes.

Firing. The routine of firing should be so arranged that no two furnaces in boilers connected to the same stack shall be open at the same time. If this is not practicable, then care must be taken to avoid at least firing at the same time furnaces in opposite ends of double end boilers, especially if there is a common combustion chamber. Two furnaces in a single end boiler, or in the same end of a double end boiler will, of course, never be fired at the same time. It is now well understood that firing light and often is better than heavy and at greater intervals. There is, however, a limit to this, for the oftener the firing the more are the furnace doors open and the more is the draft subject to disturbance, while the arrangement of a suitable routine becomes more and more difficult.

Light and frequent firing, especially with water-tube boilers, is now, however, the rule where the best results are to be obtained. The furnace door should be opened smartly and kept open only the minimum time needed to get the coal on. Hard coal is spread in as even a layer as possible over the grate. For firing soft coal two methods are available. When firing for coal efficiency, that is to get the most heat out of a pound of fuel, the coal should be first charged in front and coked, and then should be pushed back and burned. When firing for weight efficiency, that is to get the most power out of the boiler, the former method would be too slow and the coal must be spread over the fire and burned without waiting for the separate distillation and combustion of its gases. Where the coal runs irregular in size the large lumps should be broken into pieces not larger than the fist. The thickness of the fires varies with the conditions, from six to ten or twelve inches, or even thicker under a heavy forced draft. With a given speed of fan the air pressure in the ash-pits will vary widely with the thickness of the fire, rising as it is thicker, and falling as it is thinner and the air finds more ready passage through. With a thick fire it will therefore be easy to get a strong draft pressure in the ash-pits, while with a thin fire it will be perhaps impossible, even with a much higher speed of fan. A strong draft pressure will not, however, produce the corresponding rate of combustion unless the thickness and condition of the fire are such that the pressure is able to drive through it the necessary amount of air. For the best combustion the thickness of the fire should be so adjusted to the draft pressure that the latter is able to drive the necessary air through, and keep it in a state of active combustion throughout from fire grate to upper surface. Care must be taken to keep the grates evenly covered, especially at the back, and to prevent the formation of relatively thin or bare spots. A spot which is relatively thin allows of the passage of relatively more air. This further increases the combustion at that point and the spot becomes still thinner, thus allowing more and more air to escape freely instead of passing through the remainder of the fire as it should.

In the intervals of firing the pricker and slice bars may be used to clear away the ashes and clinker, if such is forming. Care should be taken to prevent the formation of dull or dead spots due to the accumulation of ashes or clinker, especially at the corners of the grate. Among old firemen a familiar saying relating to this point is: "Take care of the corners and sides of the fire and the middle will take care of itself."

The ash-pits should also be kept clear of ashes, for if allowed to accumulate they will prevent the passage of air to the grate, especially at the back. If the passage of air is thus interfered with to any considerable extent there will be also danger of overheating the grates and of bringing them down into the ash-pits.

In connection with the use of the slice bar, it must not be forgotten that every opening of the furnace door means an inrush of cold air into the furnace, a checking of the draft, a disturbance of the combustion, and often severe strains on the structure of the boiler, due to the sudden chilling and contraction which the heating surfaces undergo. If shaking grates are fitted much of this cleaning may be done without opening the door, though no form of grate is quite able to deal satisfactorily with coal showing a decided tendency to form clinker.

In thus working the fires a certain amount of fine unburned or partly burned coal will be shaken down into the ash-pit. In some cases this forms so large a part of what comes through the grate, that it may be immediately thrown on to the fire and burned over again. In most cases a sifting or washing of the ashes and separation of the combustible from the non-combustible would show a surprisingly large per cent to be available as fuel, and some saving could usually be effected in this way. It is rare, however, that anything of the kind is attempted, as with present prices of coal it may be doubted whether the additional appliances and labor would be paid for by the saving effected.

ENGINEERS' DICTIONARY.—XXVIII.

Mean Effective Pressure—By the *effective* pressure we understand the resultant of two pressures acting in opposite directions, as for example, one on the bottom of the piston acting upward, and one on the top acting downward. The *mean* effective pressure will then be the mean resultant of such pressures for a stroke or for a revolution. Referring to Fig. 88 the mean forward pressure (say downward) will be given by the mean of the ordinates from the line of zero pressure R S to the upper boundary of the card A B C D, while the mean back pressure (upward)

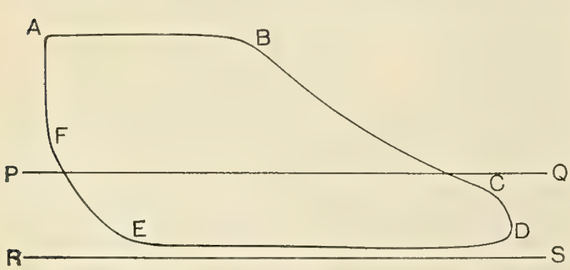


FIG. 88.

will be given by the mean of the ordinates from R S to the lower line of the card F E D. The mean resultant or mean effective pressure will then be given by the difference between these two means, one down and the other up. This result will therefore be given by the mean of the vertical heights of the diagram itself, or in other words, by the mean vertical height of the diagram. This is obtained by dividing the area by the length, and reducing the mean height thus expressed in inches, to pressure according to the scale of the diagram. The term mean effective pressure is often expressed by the abbreviation m. e. p. The use of the m. e. p. in the computation of the indicated horse-power is explained under HORSE-POWER.

Metallic Packing—With the common use of steam of higher and higher pressures, the various forms of fibrous packing for piston and valve-rods have become more and more unsatisfactory, and in modern practice metallic packings have come into almost universal employment for all such cases. There are many different forms of metallic packing, but in nearly all the fundamental features are similar, and consist in the use of

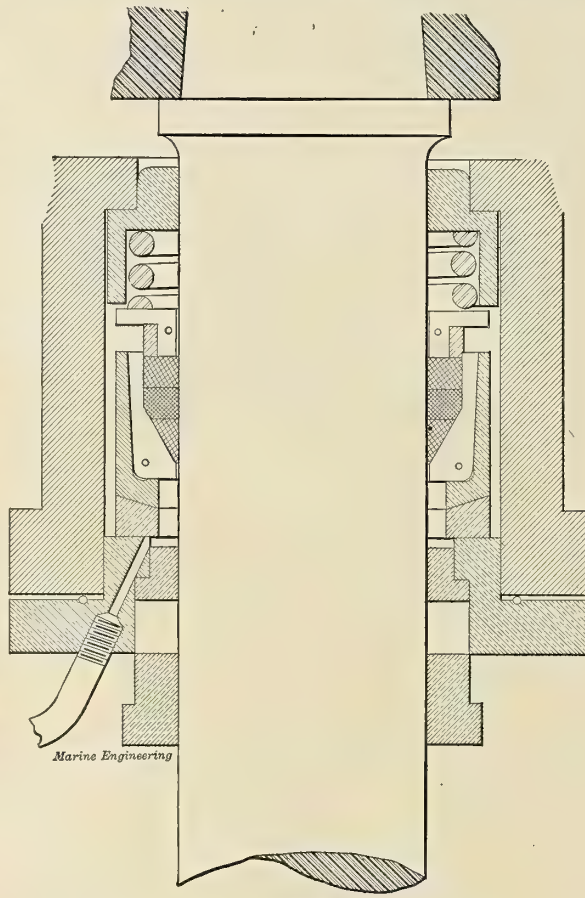


FIG. 89.

rings of white metal or other bearing alloy, cut in sections and carried or supported by rings of brass or other like material. They are also frequently arranged so that springs of one form or another will bear on the rings and force them into contact with the moving rod, and thus secure the pressure between the rings and the rod necessary to make a tight joint. In Fig. 89 is shown a representative form of metallic packing, made specially for use with high-working pressures.

Among the large American owned steam yachts recently fitted out for cruising in European waters are the *Sultana*, 390 gross tons, John R. Drexel, owner; the *Alcedo*, 552 gross tons, George W. Drexel, owner; and the *Aphrodite*, 1,148 gross tons, Col. O. H. Payne.

TECHNICAL PUBLICATIONS.

STANDARD DESIGNS FOR BOATS OF THE UNITED STATES NAVY. By Chief Constructor Philip Hichborn, U. S. N., Chief of Bureau of Construction and Repair. First Edition, 1900. Government Printing Office, Washington, D. C. Size, 15½ by 13. With 221 plates.

This publication, in the language of the bookseller, is a "monumental work." It is one of those rare technical publications that will endure for all time, possibly long after the period in which the apparatus it describes is used by mankind. It is a collection of specifications, schedules of material, weights, and costs, of each and every type of boat now used in the United States Navy. The data is really exhaustive. In the specifications are included the sizes of every bit of material which enters into the construction of a Navy boat; scantlings, fastenings, spars and sails being in turn given in detail. The schedules of material, labor, itemized weight and cost are very minute and complete to a ten-penny nail. In the case of steamboats, the general description of the machinery gives the principal dimensions and type of apparatus employed. In addition to these details there are large scale drawings of the lines, mould loft dimensions, profiles, plans and sections and detail drawings, so complete that not a single word of explanation would be needed for the builder to produce the complete boat. Each type is also illustrated in different positions by fine half-tone engravings.

For a long time the Construction Bureau labored to standardize the Navy boats, and it has finally achieved this desirable result. Now the assemblage of this data in one cover will enable any competent boat builder, in case of emergency, to turn out Navy boats in the briefest possible time—boats in which the fittings will be interchangeable.

The value of a publication of this sort is greater than the special information which it contains. It is one of those instruments that makes for progress in every direction, that impresses the builder with what can be accomplished by systematic work in what at first would seem to be a relatively unimportant field. It also sets a high standard for the recorder of progress in marine construction, and is an expression of that liberal exposition of methods that has always been associated with the profession of engineering in America. No private individual or concern could, of course, produce such a work with any hope of return of the capital invested, not to speak of profit. In this connection it is a matter of slight regret that the double plates were not inserted so that they could be stretched out flat for examination, and that a better quality of paper and ink was not used for the text pages. The book is such a splendid collection of data that the Government printer might well have striven to have reached in his work the standard of excellence set by the distinguished author.

MACHINISTS' AND DRAUGHTSMAN'S HANDBOOK. By Peter Lobben, M. E. First edition, 1900. D. Van Nostrand Co., New York. Size 5 1-2 by 8. Pages 438. With drawings. Cloth, $2.50.

This is a compilation intended as a reference book for all who are interested in mechanical work. The first part is devoted to the rudiments of arithmetic, algebra, geometry and geometric drawing, mensuration, and weights and measures, compiled in a manner to be of assistance to a mind not trained in technical matters with the view of applying the rules to the mechanical problems explained further on. Next is a chapter on strength of material, with tables, and a chapter on mechanics, in which the elementary principles are discussed. Following this is a chapter on the power required to drive different kinds of machinery and shop tools and the necessary speeds, and different problems on belting and various kinds of power transmission and shafting are explained. The article on gear teeth, bevel gear, and worm gear is very complete, and will be appreciated by those who contemplate the study and the laying out of gears.

COMPOUND ENGINES. By F. R. Low. First Edition, 1900. Power Publishing Co., New York. Size 5 1-2 by 8 3-4. Pages 52. With many diagrams. Cloth, flexible cover, 50 cents.

This pamphlet is a collection of "lectures" or papers published in *Power*, and intended to give in the clearest and simplest language the fundamental principles of the theory and operation of compound engines. The author has had a long and successful experience in presenting engineering facts in the simplest manner, and especially for those not acquainted with the higher mathematics. The present work seems in general to come up to the high standard already set by the author in this field of engineering literature.

In Lecture XIV the author discusses at length and in an interesting manner the question of receivers, joining issue to some extent with Seaton regarding the size of receiver suitable for engines with various crank angles, and in particular regarding the question whether an engine with cranks at 180 deg. may properly be given a smaller receiver than one with cranks at 90 deg. or 120 deg. It is probably true that Seaton has somewhat exaggerated the extent to which the receiver of a compound engine with cranks at 180 deg. may be decreased, and it is true that with equal points of cut-off in both high and low pressure cylinders the variation of pressure and temperature in the high pressure is in general independent of the crank angle, and in particular it will be the same whether the cranks are at 90 deg. or 180 deg., or at least such will be the case so long as the high pressure is exhausting at the instant of low pressure cut-off. It may be remarked on the other hand that with marine engines, the type to which Seaton especially refers, the points of cut-off are never found as early as 1-4 stroke (the point assumed in the present pamphlet), but rather at values of .6 to .75. Under these circumstances the variation of pressure will not be as wide as with the earlier points of cut-off, and the question of the volume of the receiver is of relatively less importance.

Further in the actual engine the distribution of pressure and of work does not, of course, go in quite so simple a manner as indicated by the computations given. Such computations can only give a first approximation to the actual facts of the case. There are many secondary influences which affect the result, and in general in such manner as to decrease the variation of pressure and temperature.

Taken as a whole, this collection of lectures or talks contains a large amount of valuable information relating to compound engines, and put in such a way as to be of interest and real help to those who wish an elementary presentation of the subject. The text is excellently supplemented by a large number of diagrams and engravings, specially prepared for the purpose.

Popular Science Monthly, for nearly thirty years published by D. Appleton & Co., has recently passed into the hands of McClure, Phillips & Co., of New York, and is now edited by J. McKeen Cottell, of Columbia University. The new owners propose to keep this monthly abreast of the needs of the day, of value to both men of science and the general public, and as an earnest of their intentions, they publish a magnificent list of American scientists who will be numbered among the contributors. Already the appearance of the publication has been greatly improved, though it seems a mistake in this busy age to put out a magazine with uncut pages. This is a remnant of old fogeyism that will not be appreciated by the up-to-date reader. There was formerly supposed to be some sort of connection between untrimmed books and deep learning, a sort of combination of erudition and inconvenience, but the busy professional inquirer cannot see the advantage of a repeated use of the paper knife when one stroke of the binder's guillotine would do the work. It is a waste of energy that might far better be utilized in absorbing the contents of the papers. There is a splendid future for this publication so long as science is not popularized into absurdity or degraded by sensational exaggeration. Neither would the other extreme of dry-as-dust discussion be likely to hold a wide circle of readers. Judging by the present issue the happy medium has been attained. The subscription price is $3 a year.

Brown's Pocket Log and Diary for Marine Engineers is a useful companion. It contains ruled pages for engine and fire room data for every day in the year, which, if properly filled up, would give a collection of most useful facts. There are also useful trial trip and coal consumption tables, night signals of various lines, tide tables for European ports, diary, with separate space for memoranda for every day in the year; standing orders, station bills, weights and measures and other data, distance tables, etc. It is a compact little book and is sold at the low price of one shilling by James Brown & Son, 58 Great Clyde St., Glasgow, Scotland. Another publication by this house is Brown's Nautical Almanac, a book of more than 300 pages, which sells for one shilling and threepence by post. This book is invaluable to deck officers on vessels in the foreign trade, and especially to deep-water yacht masters. It contains a vast amount of information for ready reference.

A collection of sea and patriotic songs, by James Lowe Pilling, Master Mariner, entitled "The Keel of the Kearsarge," has been handsomely issued in pamphlet form by the author. It is dedicated to Rear Admiral Philip Hichborn, U. S. N., and is for sale by Robinson & Smith, 350 Dearborn St., Chicago.

S. Y. SHEMARA.—The steam yacht *Shemara,* owned in Leith, Scotland, has been chartered for the season by Henry C. Frick, of Pittsburgh. She is of these dimensions: Length, 188 ft.; beam, 26 ft.; depth, 15 ft.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Will you please answer the following questions:

(1) Will a single cylinder condensing engine do more work than a non-condensing engine of the same size, with the same steam pressure and point of cut-off, and why?

(2) Why is the low pressure cylinder of a compound engine larger than the high pressure cylinder?

W. H. S.

A.—(1) Yes. The reason may be put in a variety of ways. Perhaps the following will be as simple as any:

First suppose the engine non-condensing and consider a single stroke. On the steam side the steam enters up to the point of cut-off, and then expands down to exhaust opening, passing through a certain definite series or history of pressures from one end to the other, and giving a certain mean forward pressure which we may call p. On the exhaust side we shall have the movement of the piston opposed by the exhaust pressure, which will be two or three pounds above the atmosphere, or say 17 lbs. above the zero of pressure. Then the mean *net* pressure for the stroke will be p decreased by the 17 lbs. back pressure, or ($p-17$).

Next consider the same engine with the same point of cut-off, but made condensing. On the steam side the steam enters as before and goes through the same history of cut-off and expansion, and has the same history of pressure and the same mean forward pressure. On the exhaust side the cylinder is now connected to the condenser, within which is a partial vacuum produced by the condensation of the steam by cold water and maintained by the air pump. The pressure usually maintained is from 2 to 3 lbs. above the zero of pressure, or some 12 or 13 pounds below atmospheric pressure, or, as we may say, some 12 or 13 lbs. of vacuum. The pressure within the cylinder on the exhaust side will then be reduced to only slightly above the same figures, and we may take it as 3 lbs. for the average. Hence the mean *net* pressure for the stroke will now be $p-3$ instead of $p-17$.

It is easy to see that in the cylinder itself, and for this stroke there has been gained an amount of work corresponding to a load of 14 lbs. acting on the piston through the length of the stroke.

This is not, however, quite clear gain, for the circulating and air pumps must be operated in order to supply the condensing water and maintain the vacuum, and the work which they require must be charged against this gain. It results, however, that the work thus required by the pumps is much less than the gain in the engine cylinder, so that there remains for the condensing engine a substantial increase in the work given per stroke and per minute.

(2) The purpose of the compound engine is to divide up the total expansion of the steam into two steps. The first is carried out in the high pressure cylinder by cut-off in the usual way. After the high pressure stroke is completed the expansion is then continued and completed by exhausting the steam from the high pressure to the low pressure cylinder, so that by the end of the low pressure stroke the steam which once filled the high pressure cylinder will now fill the low. Now it is clear that if the low pressure and high pressure volumes were the same there would be no expansion and no gain of work in this way. The change would be simply a shift of the steam from one place to another, but without change of volume or other conditions. Hence, to secure the desired expansion, the low pressure cylinder must be larger in volume than the high, and this is the reason why they are so made.

Q.—Can you kindly furnish me with the respective contract numbers of the Denver class of cruisers?

H. T.

A.—The *Denver* class of U. S. cruisers are officially numbered as follows: *Denver*, Cruiser No. 14; *Des Moines*, Cruiser No. 15; *Chattanooga*, Cruiser No. 16; *Galveston*, Cruiser No. 17; *Tacoma*, Cruiser No. 18; *Cleveland*, Cruiser No. 19.

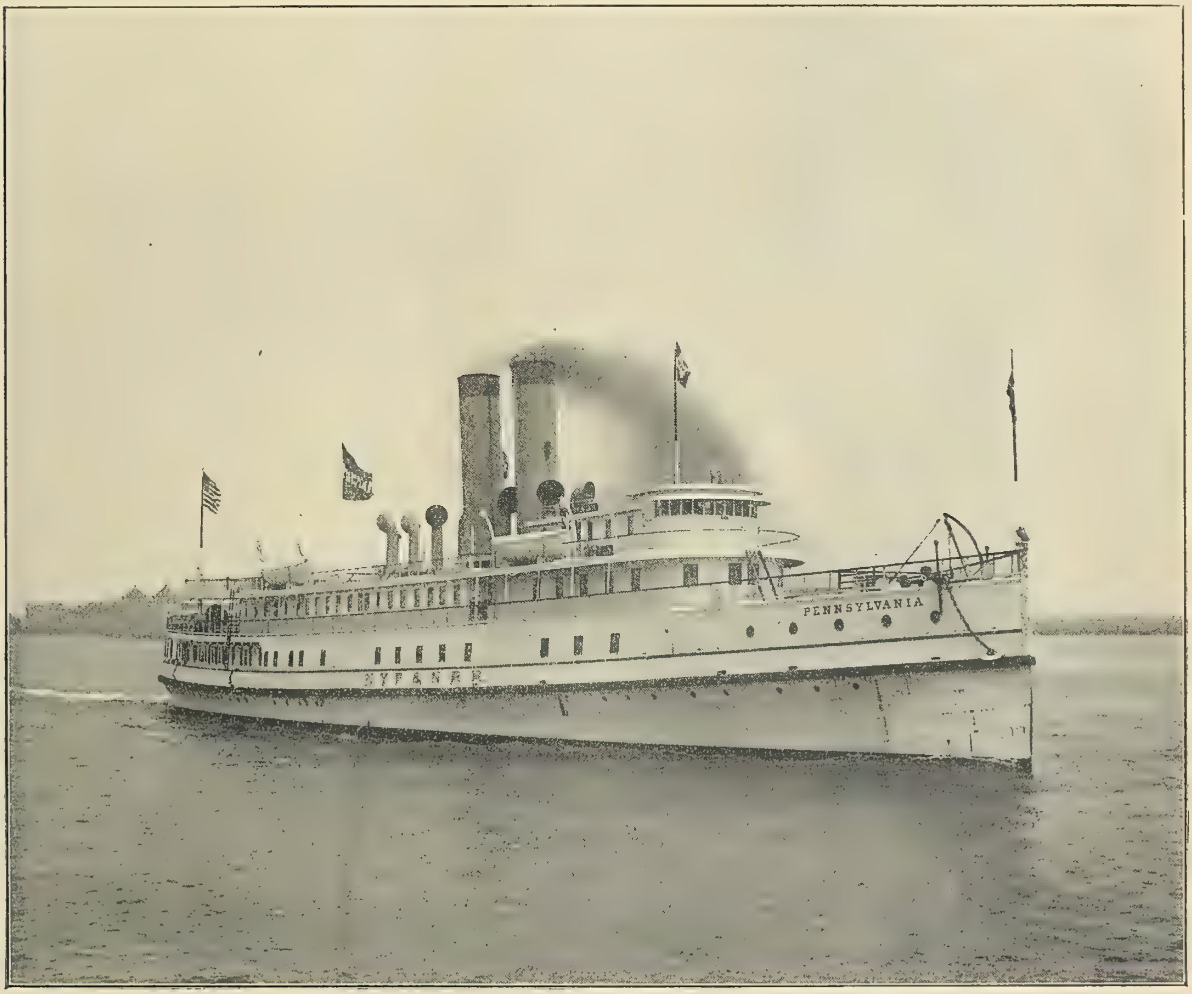
Miss Helen Gould has donated the sum of $150,000 towards the construction of a magnificent new building for the naval branch of the Y. M. C. A., near the Navy Yard, Brooklyn, N. Y.

MARINE ENGINEERING.

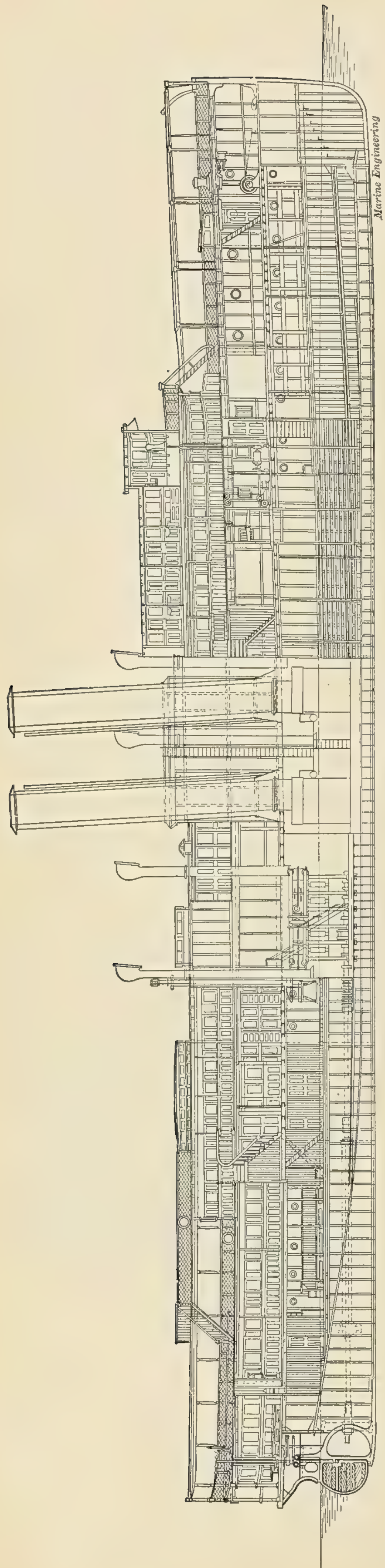
Vol. 5. NEW YORK, JULY, 1900. No. 7

TWIN SCREW STEAMBOAT "PENNSYLVANIA" BUILT FOR THE CAPE CHARLES ROUTE.

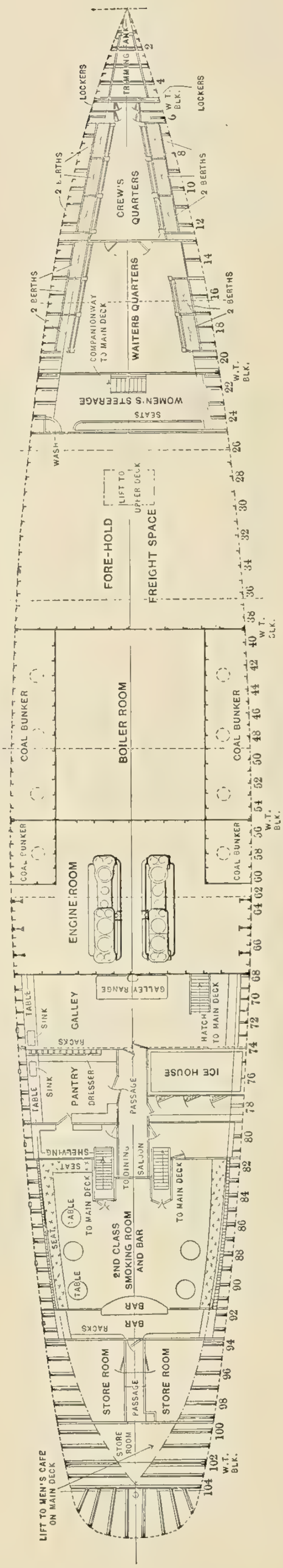
An unusually interesting vessel, the T. S. S. *Pennsylvania,* was recently put into service on the waters of Chesapeake Bay in what is generally known as the Cape Charles Route. This service is maintained by the New York, Philadelphia and Norfolk Railroad Company, which operates its land lines from Cape Charles, Va., to Delmar, Md., where connection is made with the Pennsylvania Railroad system. There are close traffic connections between these companies, through trains being operated between Cape Charles and Philadelphia and New York, making connections at the latter for more distant points. The steamship route connects Cape Charles with Norfolk, Va., touching at Old Point Comfort. The steamboats of the N. Y. P. & N. R. R. Co. carry not only passengers and their baggage, but freight between these points. The service is performed twice a day, and with the present facilities passengers can leave New York at 8.55 p. m. and reach Norfolk in time for breakfast next day, or on returning they can leave Norfolk at 6 p. m. and arrive in New York at 7.32 a. m. next morning. The



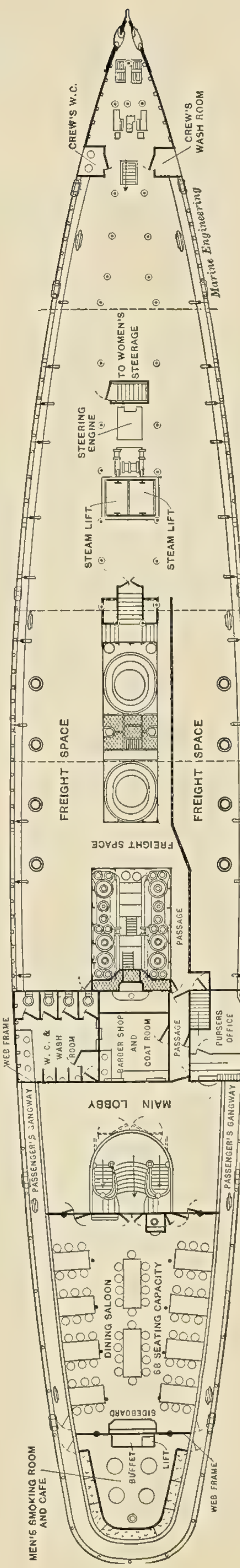
TWIN SCREW FAST PASSENGER AND FREIGHT STEAMBOAT PENNSYLVANIA ON "CAPE CHARLES ROUTE."



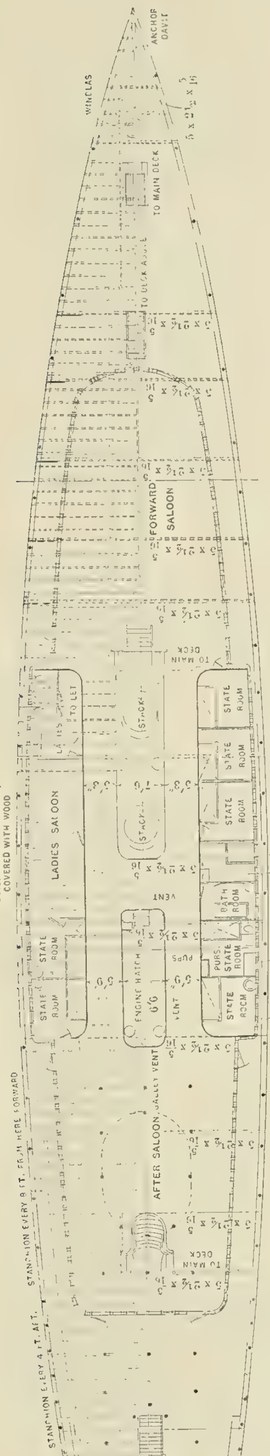
INBOARD PROFILE.



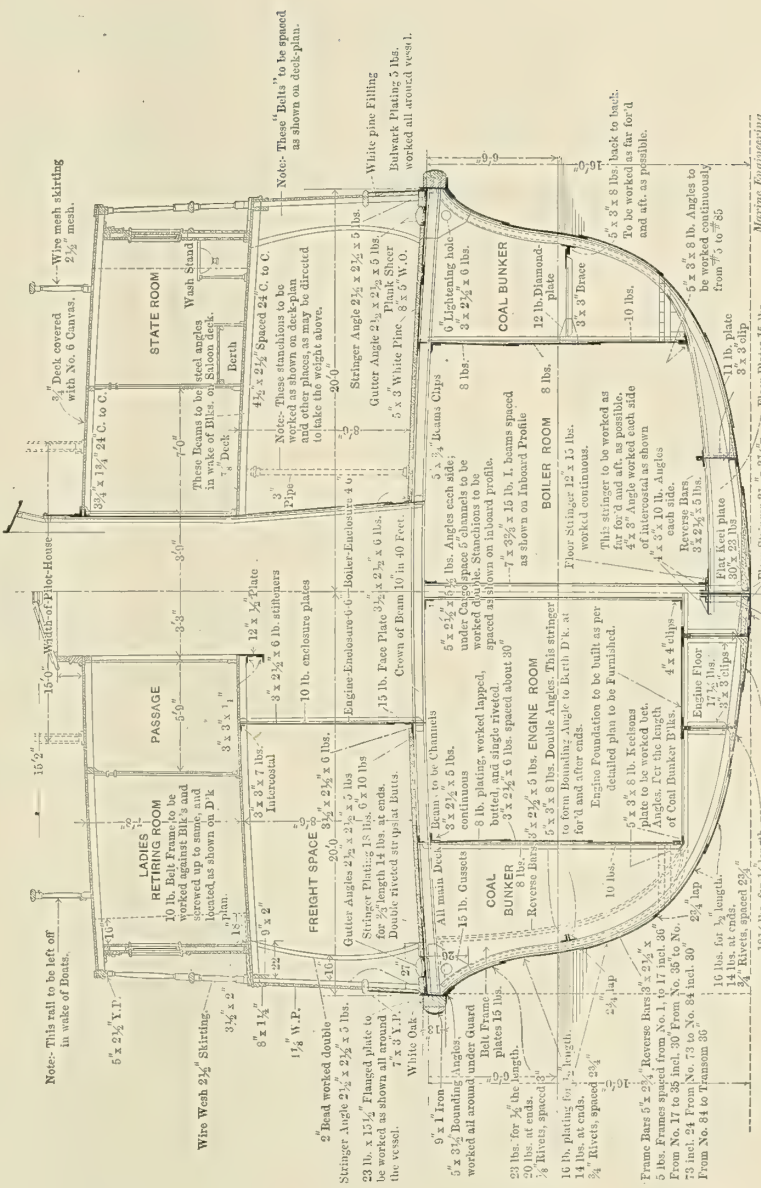
LOWER DECK.



MAIN DECK.



SALOON DECK.



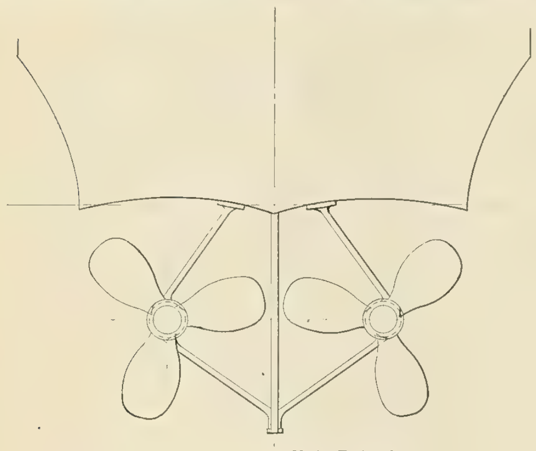
CROSS SECTIONS.

PLANS OF THE T. S. PENNSYLVANIA FOR N. Y. P. & N. R. R. CO. DRAWN BY GARDNER & COX, NEW YORK. VESSEL BUILT AT ROACH YARD, CHESTER, PA.

average number of passengers handled on the Cape Charles route is about 150 and the weight of baggage 20,000 lb. In addition a large quantity of high class freight is handled, especially northbound perishable stuff, the average being about 4,000 barrels, consigned to New York and Philadelphia merchants, each trip. The freight capacity of the *Pennsylvania* is about 300 tons.

The distance from Cape Charles to Norfolk, Va., is about thirty-five miles, and the run is made by the *Pennsylvania* on a schedule of two hours and fifteen minutes, in which is included a stop at Old Point Comfort of about twenty minutes. This run does not indicate the actual speed of the boat, for the reason that there are speed restrictions for a considerable distance in Norfolk Harbor, and again there is shallow water on the eastern side of the bay, where it is not possible to attain full speed. The maximum service speed of the *Pennsylvania* is about 18 knots. The service is continued throughout the entire year.

As shown in our frontispiece, the new steamer is a handsome, shipshape, vessel, with the usual American steamboat superstructure, two well proportioned funnels and a pleasing amount of sheer. Her chief point of peculiarity, or difference from other vessels engaged in similar service, is that she has a modified torpedo boat or knuckle stern. This is not so readily distinguishable in the photograph as in the small stern view in outline on this page. The stern of the *Pennsylvania* differs from the regular torpedo boat stern in that it has practically two sterns divided at the knuckle in the same style as the English channel steamer *Tamise,* of 1,000 tons. The *Pennsylvania* was designed by Naval Architects Gardner & Cox, of New York, and built at the Roach yard, Chester, Pa.



Marine Engineering

STERN OF T. S. S. PENNSYLVANIA.

Her principal dimensions are: Length over all, 260 ft.; between perpendiculars, 247 ft.; beam moulded, 37 ft. 8 in.; beam over guards, 40 ft. 9 in.; depth molded at center, 15 ft.; depth molded at side, 14 ft.; depth of hold, 13 ft.; draft, 9 ft. 6 in.; displacement about 1,100 tons.

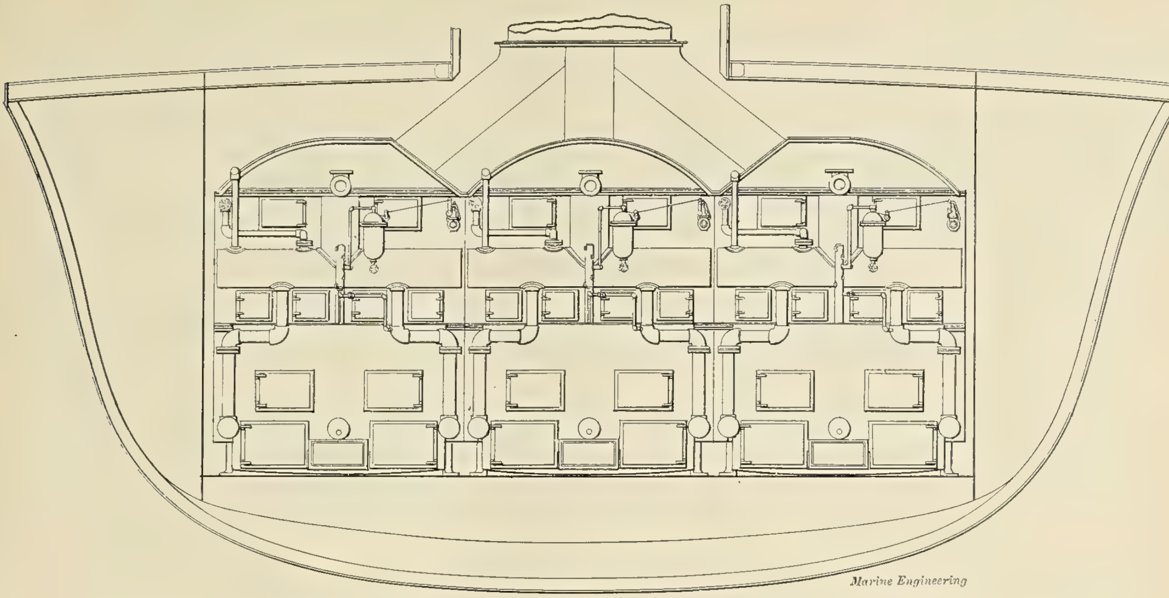
The steel hull of the vessel is heavy and rigid, and the scantlings are equal or in excess of the requirements of the U. S. Standard Association. The frames are of 5 in. bulb angles, spaced 36 in. apart from Nos. 1 to 17, and from No. 84 to transom; 30 in. apart from Nos. 17 to 35 and from Nos. 73 to 84; and 24 in. apart from Nos. 35 to 73. Reverse frames are 3 in. by 2 1-2 in. by 5 lb., angle bars extending to the upper turn of the bilge. Floor plates are 24 in. deep, of 15 lb. plate, and 17 1-2 lb. in the engine space. The vertical keel is 28 1-2 in. by 15 lb., and extends from the flat keel to 5 in. above the top of the floors. It is secured to the keel plate by double 3 1-2 in. by 3 1-2 in. by 10 lb. angles, and at its upper edge by 4 in. by 3 in. by 10 lb. angles. The flat keel plate is 30 in. by 23 lb. A side keelson formed of intercostal plates, with double continuous 4 in. by 3 in. angle bars is worked amidship and as far forward and aft as practicable. The bilge keelsons consist of two 5 in. by 3 in. by 8 lb. angles, riveted back to back. In the machinery space the wing bulkheads are placed on the line of this keelson. A side keelson is formed of 5 in. by 3 in. by 8 lb. angles riveted back to back and extending practically the entire length. The main deck beams are channel section 7 in. by 2.01 in. by 12 lb., and reduced to 6 in. by 1.9 in. by 9.5 lb. at the ends. They are located in every alternate frame.

On the accompanying cross section the arrangement of guards and stringer plates is clearly indicated. The shell is plated with in and out strakes, with 7 strakes on each side, not including the flat keel. For the sheer strake 23 lb. plate is used for half the length and 20 lb. at the ends. The rivets are 7-8 in., spaced 3 in. apart, and the lap is 2 3-4 in. Side and bilge plating is 16 lb. for half the length, reduced to 14 lb. at the ends, with 3-4 in. rivets spaced 2 3-4 in. Bottom plates are 18 1-2 lb. for half length and 14 and 15 lb. at the ends Deck stanchions of 7 in. by 3 2-3 in. by 15 lb. I-beams are worked in the center line of the vessel about 8 ft. apart. The main deck stringers are of 18 lb. for two-thirds of the length and 14 lb. at the ends, with double riveted straps at the butts. White pine planking is used for the main deck, 5 in. by 3 in. Above the guard the bulwark plating is 5 lb. worked all around the vessel, and filled with 1 3-8 in. white pine up to the main rail, and from this up to the saloon deck the sides are of 1 1-8 in. white pine. The saloon deck is 8 ft. 6 in. above the main deck, and is constructed of 7-8 in. tongued and grooved stock, laid on 4 1-2 in. by 2 1-2 in. wood carlines spaced 24 in. centers.

Above the saloon deck, 7 ft. 8 in., is the upper promenade deck, of 3-4 in. matched boards, covered with No. 6 canvas and painted with French yellow. This deck is laid on carline 3 3-4 in. by 1 3-4 in., 24 in. centers. The saloon deck extends the whole length of the vessel; but the house, which is 150 ft. long, extends close to the sides, so on this deck the outside passenger deck space is quite limited, and occupants of the interior rooms can enjoy a considerable degree of privacy.

The promenade deck commences about 45 ft. abaft the stem and runs to the stern, but passengers are excluded from the after 38 ft. of this deck. At the two ends of the vessel a lower deck is worked.

Commencing on this deck, at the forward end, aft of the collision bulkhead, is the chain locker, which extends from the keel to the main deck. Next comes a room about 23 ft. long, with berths and lockers, for the accommodation of the dozen sailors or deck hands. Aft of this room is another compartment about 21 ft. 6 in. long, similarly fitted with ten berths and used as



CROSS SECTION OF FIRE ROOM, T. S. S. PENNSYLVANIA, SHOWING ALMY WATER TUBE BOILERS IN POSITION.

the waiters' quarters. Next to the after bulkhead of the waiters' quarters comes the women's steerage about 10 ft. in a fore and aft direction and extending the width of the vessel. This is reached by a staircase leading down from an enclosure on the main deck just forward of the steering engine room. The next 33 ft., from the women's steerage to the boiler room bulkhead, is occupied by the fore hold, from which freight is handled by a steam lift at the main deck hatches. The next 31 ft. is occupied by the boiler room which measures 25 ft. athwartships. The wing coal bunkers are worked 42 ft. long and extend from

INSTANTANEOUS PHOTOGRAPH OF T. S. S. PENNSYLVANIA GOING AT A HIGH RATE OF SPEED.

the forward boiler room bulkhead into the engine room on both the port and starboard sides. The boilers being of the Almy water tube type fit together very compactly as shown in the cross section of the vessel, through the stoke hold on page 277. The engine room is about 25 ft. in length. Abaft of the engine room comes the galley 12 ft. in a fore and aft direction and the width of the ship. Aft of the galleys, pantries, store rooms and refrigerators, and the stairways to the main saloon, occupy about 21 ft. of the length of the vessel. Next aft comes the second class smoking room and bar occupying about 28 ft. in a fore and aft direction. This is comfortably fitted with upholstered seats and six tables, and is, of course, unusually spacious, owing to the form of stern of the vessel. Wine lockers and store rooms utilize all of the vailable space left of this room, including the lazarette.

On the main deck the forward 150 ft. is used as space for freight and baggage, the engine and boiler trunks forming the only considerable obstructions for a clear freight space. On the starboard side of these inclosures a partition is worked, as shown on the plan, giving a clear passageway fore and aft between the passenger and crew spaces on this deck at all times. Aft of the engine hatch the purser's office and ticket office is located, on the starboard side the barber shop and coat room amidships, and large passengers' lavatory on the port side. Next aft is the main lobby or social hall, which is 22 ft. long and about 31 ft. wide, and in which the ornamental staircases lead up to the saloon deck and below to the lower deck. Directly aft of the social hall is the main dining saloon, with 10 tables and capacity for 68 passengers at one sitting. This is a very fine, well shaped and splendidly lighted room, 36 ft. long and about 27 ft. average width. In the after end of the room a handsome sideboard is fitted. In the after end of the house on this deck there is a smoking room and café for the cabin passengers, with upholstered seats along three sides and circular floor tables. All around the house on this deck there is a passageway inside of the rail, and as the sides are not carried above the main deck, an unbroken view on each side and astern can be had.

On the saloon deck the forward saloon occupies about 46 ft. of the house, and is 27 ft. wide. The front is rounded and fitted with doors, so that the passengers can step inside and yet be sheltered by the awnings. Amidships the machinery casings occupy the center of the ship, with a passage on each side fore and aft. Along the starboard side there are six staterooms, and men's toilet room, and on the port side two staterooms, ladies' saloon with twelve reclining chairs, and ladies' toilet room. The aft deck saloon is 43 ft. long and 28 ft. wide. All the furnishings, upholstery, and fittings, are of the usual American steamboat style, the color scheme being white and gold.

On the promenade deck, forward the house, is 40 ft. long and 15 ft. wide. The forward end is occupied by the pilot house, with rounded front and glazed lifting sashes all around. Next comes the captain's room and six large staterooms for the chief engineer, first and second assistant engineers, two mates, mail clerk, oilers and purser. The remainder of the deck is broken only by the boiler room gratings, the engine hatches, ventilators, and the dome over the after saloon. The smoke pipes are elliptical in section, measuring about 8 ft. fore and aft by 5 ft. athwartships, and rising about 26 ft. above the deck.

Boats carried include four 24 ft. metallic life boats, and there is the usual supply of life rafts and life preservers. On each side of the vessel there are three large freight ports about 8 ft. square, between the main and saloon decks, and the passengers' gangways are located opposite the main lobby on the main deck.

Propelling engines of the *Pennsylvania* driving the twin screws are of the vertical four cylinder, triple expansion type, with cylinders 18 in., 29 in., and (2) 33 in dia. and 26 in. stroke. All the main valves are of the piston type worked by Stephenson gear with double bar links. The framing for each engine consists of six pairs of cast steel columns well stiffened by diagonal ties. Cast iron is used for the bed plates, which are carried by wrought steel keelson plates forming the foundation. Each crank shaft is in two sections, and all shafting, piston, and connecting rods and working parts of the valve gear are of forged steel. Each engine was designed to indicate 1,500 I. H. P. at 180 revolutions, with 200 lb. steam pressure.

Special interest attaches to the boiler equipment of the *Pennsylvania,* as we believe this is the largest installation of water tube boilers of the "small tube" variety in a passenger vessel in American waters. There are six water tube boilers of the Almy type, built to work under forced draft at a pressure of 225 lb. per square in. They are fitted forward of the engines in two sets of three abreast, and fronting on a common athwartships fire room. Each boiler occupies a space about 8 ft. square, and the fire room is 12 ft. long in a fore and aft direction and 25 ft. wide. Each group of boilers is connected to its own stack. The space occupied by these boilers is shown in the cross section through the boiler room published on page 277.

The total grate surface is 363 sq. ft. and the total heating surface 10,960 sq. ft. The weight of the water tube boilers, filled with water to the steam level and including all furnishings except the breechings and smoke stacks, is 76 1-2 gross tons.

All auxiliaries are independent. There are two independent surface condensers, each with a centrifugal circulating pump, two vertical beam air pumps, two vertical duplex feed pumps, and also the usual ballast, bilge, and sanitary pumps. Steam steering engine is also fitted, and forward there are two steam lifts on the main deck for hoisting freight in and out of the hold, and there is also the usual equipment of steam capstan and windlass. A very complete electric lighting plant also forms part of the equipment.

The *Pennsylvania* was designed to meet the contract conditions which stipulated that she should be capable of steaming at the rate of 20 statute miles per hour on a draft of 9 ft. 6 in. when carrying 300 tons of freight, besides the coal, water, stores, and passengers. These are onerous conditions, but we understand that they have been fulfilled to the satisfaction of all concerned.

The *Syren and Shipping,* London, is authority for the statement that there is now under construction at the yard of Harland & Wolff, Belfast, Ireland, a steamship whose dimensions exceed those of the *Oceanic* of the White Star Line.

Belleisle Gunnery Experiments.

It is not often that in peace time naval officers have an opportunity to attack an ironclad with modern weapons, but this was made possible recently in the British Navy by the decision to use H. M. S. *Belleisle* as a target. The *Belleisle* is an iron, twin screw, central battery ironclad, built on the Thames in 1876. She was laid down for the Turkish government, but during the "We don't want to fight, but, by Jingo, if we do" period in England she was purchased for the British Navy. She turned out to be such a fearful roller at sea that she was assigned to harbor protection duty, in which she grew more and more out of date as the years went by. Her armor ranged in thickness from 12 in. down, and her armament consisted of four 12-in. muzzle loaders in the central battery and numerous smaller cannon. Her displacement was about 4,870 tons. Last month she was taken out from Portsmouth harbor and moored ready for action, with torpedo nets, out, etc., while the battleship *Majestic*, 14,900 tons, shelled her at a range of about one mile.

In the nine minutes that the firing lasted the *Belleisle* was completely wrecked in her unprotected portions, but strange to say—according to report—she was not seriously ablaze anywhere. Viewed from a distance the vessel seemed to be on fire, as much smoke enclouded her, but on close examination it was found that this was caused not by a general conflagration, but in part by the smoke from her uptakes—the funnel had been shot away—from unexploded lyddite shells, and from small pieces of wood which had been used as "dummies."

The lyddite shells (high explosive) fired by the *Majestic* had a terribly destructive effect The force of the explosions seemed to have been directed upwards, so that shells which entered the 'tween decks wrecked the structure above and below. From the guns of 3 in. to 12 in. caliber of the attacking vessel about 615 full service rounds were fired, and it was estimated that about 30 to 40 per cent struck the mark.

After the trial the *Belleisle* sank on account of the amount of water pumped into her. The holes in the sides were subsequently plugged and she was towed to dry dock at Portsmouth for survey. She will be refitted and again experimented with.

Among the United States Government publications, those issued by the Office of Naval Intelligence have always taken high rank on account of their authoritativeness and completeness, the thoroughly practical presentation of the subjects treated and timely character of the contents. The latest issue from this office is a complete record of the Coaling, Docking and Repairing Facilities of the Ports of the World and Analyses of Different Kinds of Coal. This information is in tabular form, the various parts being grouped according to their geographical locations, so that the inquirer can see at a glance what choice of ports there is in the particular waters he may be in. For ready reference the value of the book is increased by a comprehensive index. This publication measures 6 by 9 in., and contains 400 pages. It really represents an enorous amount of patient, careful work. Now that the country is reaching out after over-sea trade, its practical value to ships' officers is very great indeed.

EQUIPMENT FOR HANDLING BULK CARGOES RAPIDLY AT GREAT LAKE PORTS*—I.

BY ARTHUR C. JOHNSON.

Sir William H. White, Director of Naval Construction in the British Navy, in a recent review before the Institution of Mechanical Engineers, says: "One of the most marked tendencies in recent construction has been the increase in size and carrying power of ships. Unless there had been a corresponding development in the means of dealing with cargo, this increase in size could hardly have occurred, and the advantages resulting from that increase would not have been realized." Further he says: "It is well realized that unless there is 'quick despatch' in loading and unloading cargoes, very serious diminutions of earnings must result from the longer detention in port. Hence it follows that for the complete commercial success of the larger classes of cargo carriers, lifting appliances of the most efficient character and of ample capacity are of the greatest importance." If this is true of ocean going vessels, where voyages are on the average comparatively long and extended, to a much greater extent is it true of vessels carrying cargo on the Great Lakes, where even with rapid loading and discharging of cargoes, the ratio of time spent in port to that spent in transit is very great, amounting to one-sixth under the most favorable circumstances. The object of this paper is to deal with the special types of machinery built for the purpose of insuring "quick dispatch" in loading and unloading the enormous tonnage of ore and coal that is shipped annually on the Great Lakes—the foundation of the gigantic steel industry that has made the United States a competitor in the markets of the world. (See map of the Great Lakes, Fig. 1.)

The shipments of ore from Lake Superior Iron Ranges represents roughly one-third of the entire freight traffic on the lakes and for this reason a large fleet of modern cargo vessels has been built specially for this trade, represented as a type by the tow barge shown in Fig. 2, the steam barges being of the same general type. The largest of these are 500 ft. long and 50 ft. beam, the distinctive feature of these boats being the large size and number of hatches, 30 to 34 ft. long by 8 ft. wide, spaced 24 ft. centre to centre along the entire available deck length. This greatly facilitates loading and unloading operations, at the expense, however, of the strength of the deck plating, since the ship is almost cut in two crosswise of her deck. In Fig. 3 is shown the cross-section of a typical ore loading dock and the method of loading vessels. The ore is dropped into the pockets from drop-bottom "Jumbo" cars running on the tracks above, and from the pockets the chutes discharge the ore into the vessels lying alongside the dock. At the end of the season of 1898 there was at the different points a total of 4,354 pockets, having a total storage capacity of 623,612 gross tons of ore, constructed at a cost of about $7,000,000. The following table gives a list of docks with principal di-

*A paper read before the Civil Engineers' Club of Cleveland and contained in the Journal of the Association of Engineering Societies.

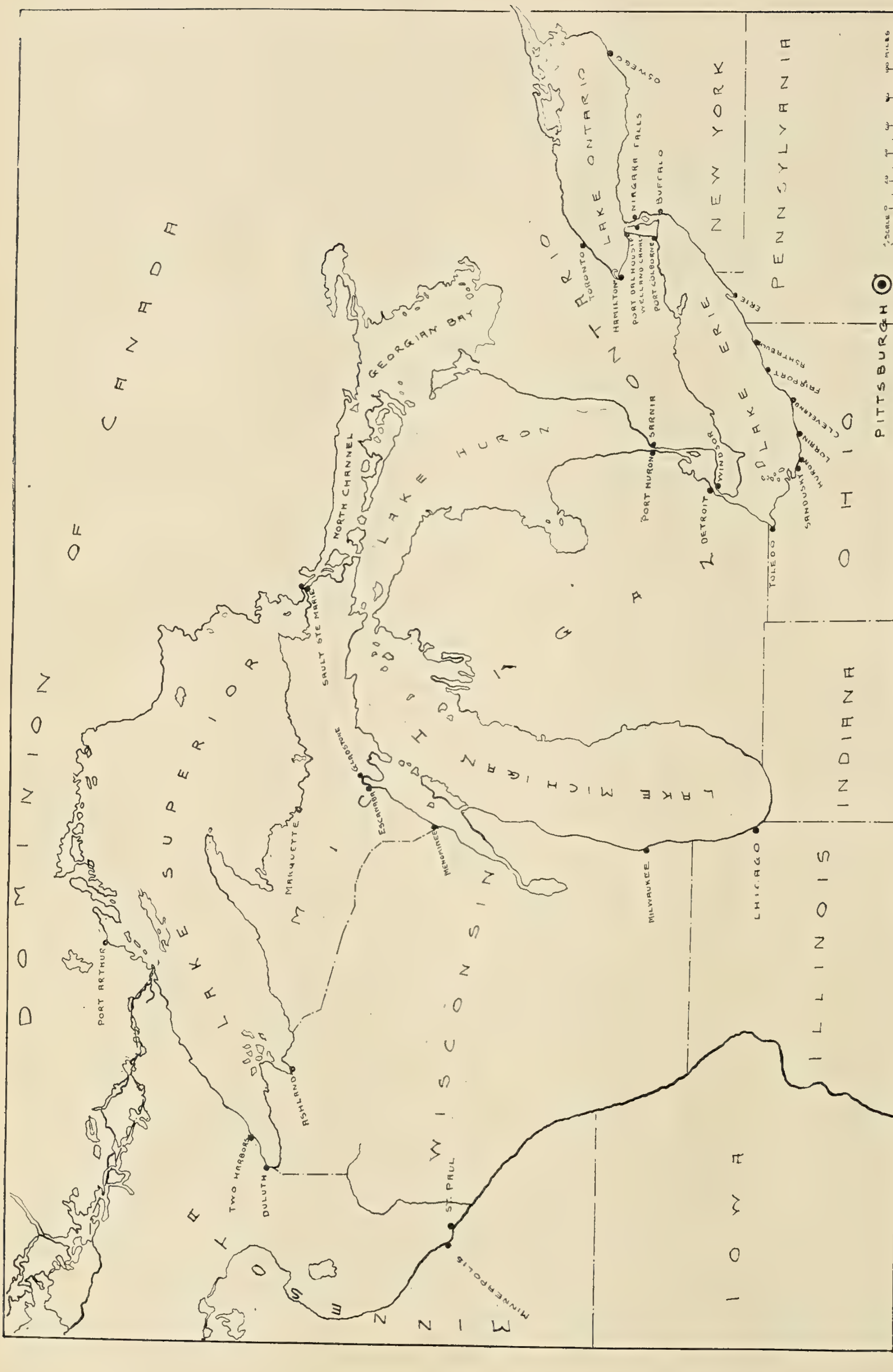


FIG. 1—SCALE MAP OF GREAT LAKES SHOWING PRINCIPAL LOADING PORTS FOR SHIPPING.

mensions and location and the names of the railway companies owning them.

Railway	Location	Dock No.	Length of Dock in ft.	Width of Dock in ft.	Height of Dock Water to Deck	No. of Pockets	Storage Cap'y Gross Tons
Duluth and Iron Range R. R. Co.	Two Harbors. Minn.	1	1,056	41′0″	45′ 6″	141	18,000
		2	1,248		57′ 0″	208	41,600
		3	340	49′0″	51′ 6″	90	16,000
		4	1,008	49′0″	51′ 6″	168	30,000
		5	1,008	49′0″	54′ 0″	168	33,000
Duluth, Masaba & Northern.	Duluth, Minn.	1	2,340	52′0″	53′ 6″	384	57,600
		2	1,738	52′0″	57′ 4″	288	42,200
Duluth, Superior & Western Ry.	Allouez Bay. Superior, Minn.	1	a- 300	49′8″	52′ 0″	40	12,000
			b-1,200	49′8″	57′ 0″	190	25,500
Chicago & North Western R. R.	Ashland, Wis.	1	1,404	46′8″	54′ 0″	234	36,036
		2	1,404	46′0″	58′ 8″	234	24,156
	Escabana, Mich.	1	1,404	37′0″	46′ 0″	184	24,104
		3	1,356	37′0″	39′ 0″	226	30,284
		4	1,500	37′0″	59′ 2″	250	37,500
		5	1,392	37′0″	51′10″	232	43,152
Duluth, South Shore & Atlantic R. R.	Marquette, Mich.	1	1,700	40′0″	45′ 0″	270	27,000
		3	1,200	53′6″	37′ 0″	213	12,780
		4	1,200	36′8″	47′ 3″	200	28,000
Lake Superior & Ishpeming.	do.	1	1,200	52′0″	54′ 0″	200	36,000
Minneapolis, St. Paul & Sault Ste. Marie R.R.	Gladstone, Mich.	1	768	37′0″	47′ 0″	120	15,000
Wisconsin Central Lines.	Ashland, Wis.	1	1,908	36′0″	54′ 6″	314	33,500

The Duluth, Masaba and Northern Ry. has now under construction a new dock which is 66 ft. 6 in. high and 62 ft. wide, the heel of the spout being 40 ft. above the water line. There will be 192 pockets, with a capacity of 21 tons each. The additional width permits the placing of a track along the centre of the dock for storing empty cars and minimizing the work of the switching engines. The dock proper will require 6,500,000 ft. of sawed timber and 4,780 pieces of piling.

The pockets of these docks can be filled with the different grades of ore ready to be discharged into the vessels as they arrive, and it is not an uncommon thing for a vessel to come alongside of one of these docks, take in a cargo of 5,000 tons of ore and depart within two or three hours from the time it reached port. In the busy seasons, however, the vessels are loaded directly from the cars by dropping the ore through the pockets. Timbers are placed across the lower hatch to break the fall of the ore, and with proper manipulation of the chutes an entire cargo can be loaded with little or no trimming. The following table gives the output of the Lake Superior ranges from 1895 to 1899, inclusive:

OUTPUT OF IRON ORE FROM ALL MINES OF THE LAKE SUPERIOR ORE REGION, 1895 TO 1899 INCLUSIVE.

Ports	1899	1898	1897	1896	1895
Escanaba	3,720,218	2,803,513	2,302,121	2,321,931	2,860,172
Marquette	2,733,596	2,245,965	1,945,519	1,564,813	1,079 485
Ashland	2,703,447	2,391,088	2,067,637	1,566,236	2,350,219
Two Harbors	3,973,733	2,693,246	2,651,465	1,813,992	2,118,156
Gladstone	381,457	335,955	341,014	220,887	109 211
Superior	878,942	550,403	531,825	167,245	117,884
Duluth	3,509,965	2,635,262	2,376,064	1,988,932	1,598,783
Total by Lake	17,901,358	13,655,432	12,215,645	9,644 036	10,233,910
Total by Rail	* * * *	369,241	253,993	290,792	195,127
Total Shipments		14,024,673	12,469,638	9,934,828	10 429,037

Practically all this ore is unloaded at South Chicago for consumption there, or at some of the Lake Erie ports for consumption in the Pittsburgh District. The relative locations of these places will be seen on the map, Fig 1. One of the most recent and largest installations of ore unloading equipments is the plant on the docks of The Lorain Steel Company, built by the McMyler Mfg. Co., and shown in Fig. 4. The plant consists of four machines of three bridges each, the distinctive feature being the long cantilever of 127 ft. overhanging the boat, and the great length of bridge The bucket travels, on a return trip from the bottom of the boat to the extreme end of the rear cantilever, 940 ft. As will be seen, the ore can be dumped on the stock piles, or through the suspended hoppers into cars, which carry it to the furnaces, situated directly be-

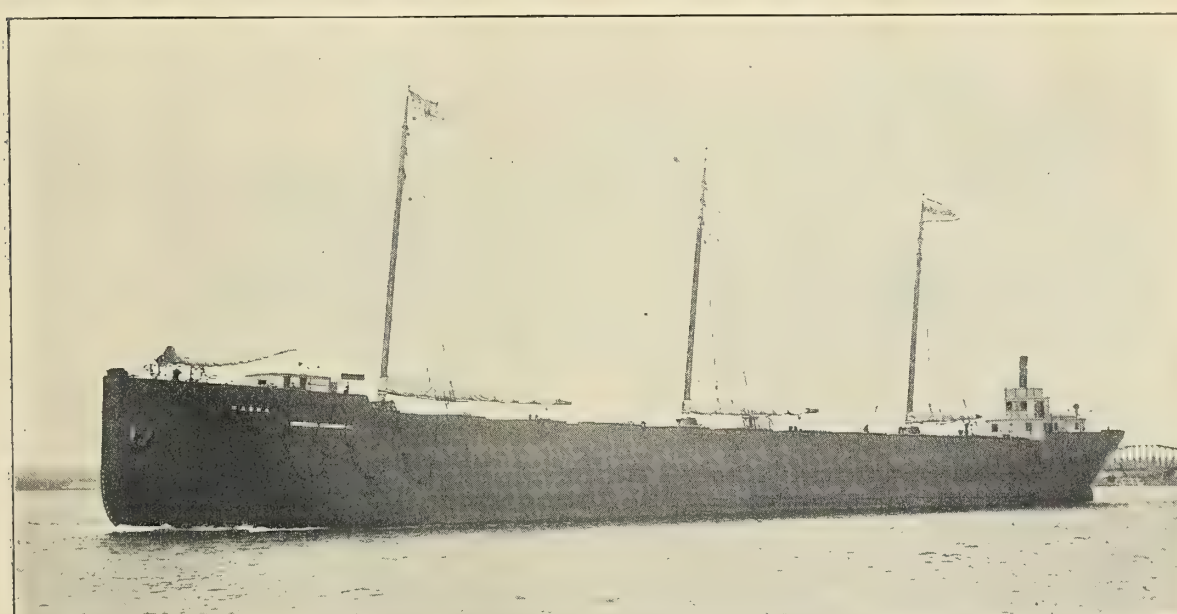


FIG. 2.—TYPICAL LAKE TOW BARGE FOR BULK CARGOES—LENGTH 352 FT., BEAM 44 FT., G. T. 3,259.

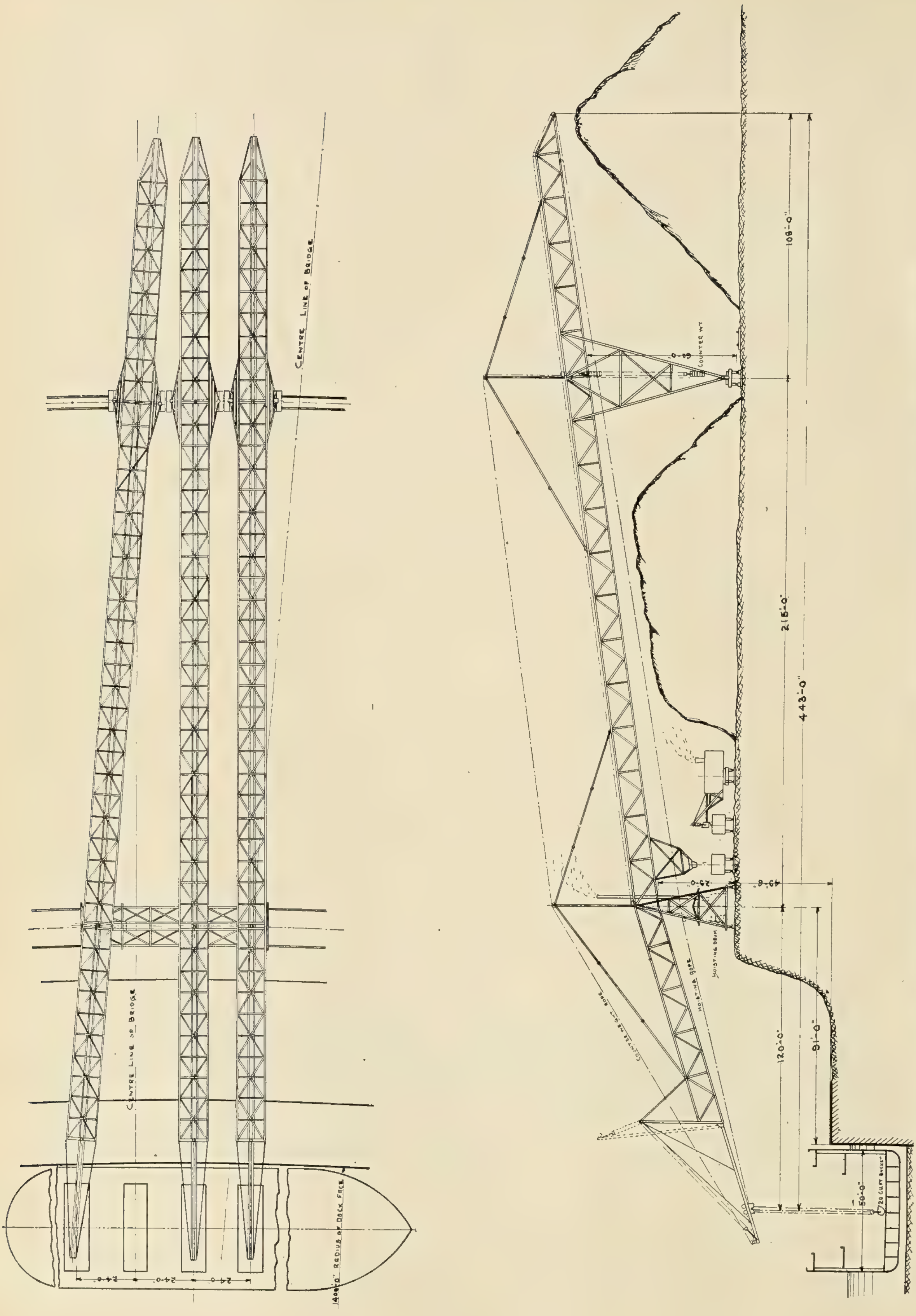


FIG. 4.—MC MYLER ORE UNLOADING EQUIPMENT IN USE AT THE DOCKS OF THE LORAIN STEEL CO., SOUTH LORAIN, OHIO.

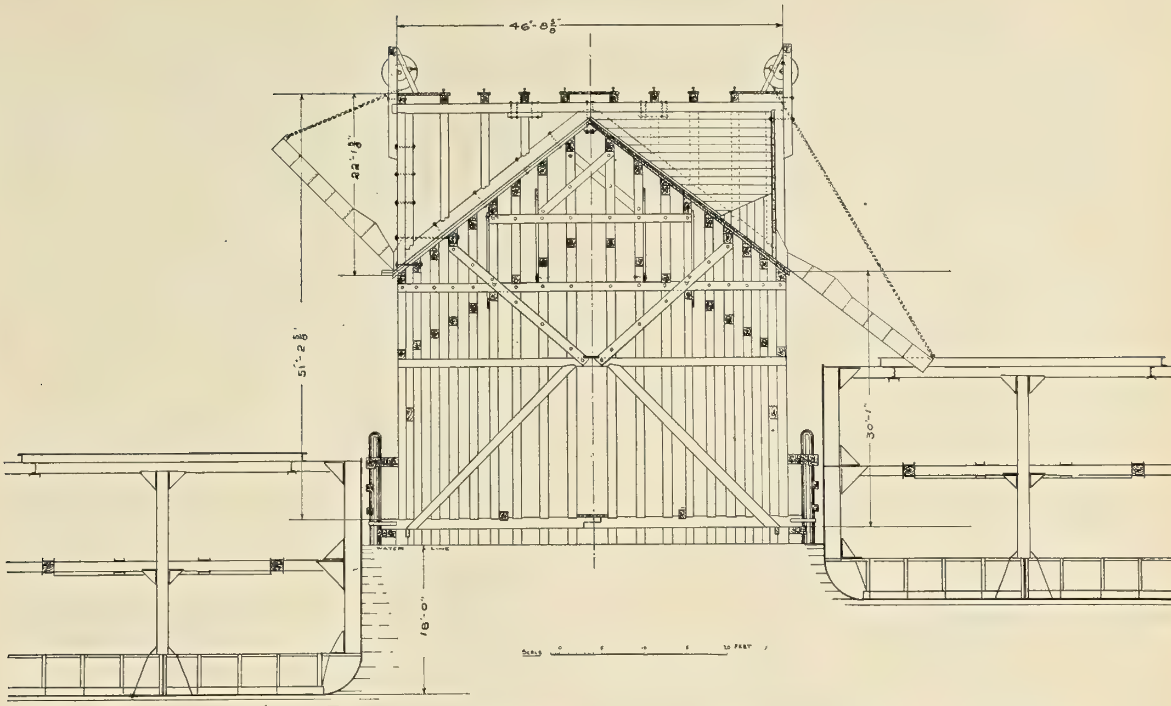


FIG. 3.—CROSS SECTION OF TYPICAL ORE-LOADING DOCK.

hind the hoists. In Fig. 5 is shown the wagon and front stop used on these machines, and Fig. 6 is a detail of the 20 cu. ft. bucket used. The most economical size of bucket for use in connection with ore hoists has been found to be from 17 to 20 cu. ft. capacity, as a larger bucket is so heavy for the shovelmen to handle that much time is lost. There are in 17 cu. ft. one gross ton of light soft ore, or 2,500 lbs. of hard ore. Each bridge of the conveyors shown in Fig. 4 is equipped with a pair of 12 in. by 12 in. non-reversing engines carrying a 40 in. drum directly on the crank shaft for the main hoisting rope. As will be seen from Fig. 5, the wagon is arranged with a "three part" hoist, but in traveling along the bridge the full circumferential

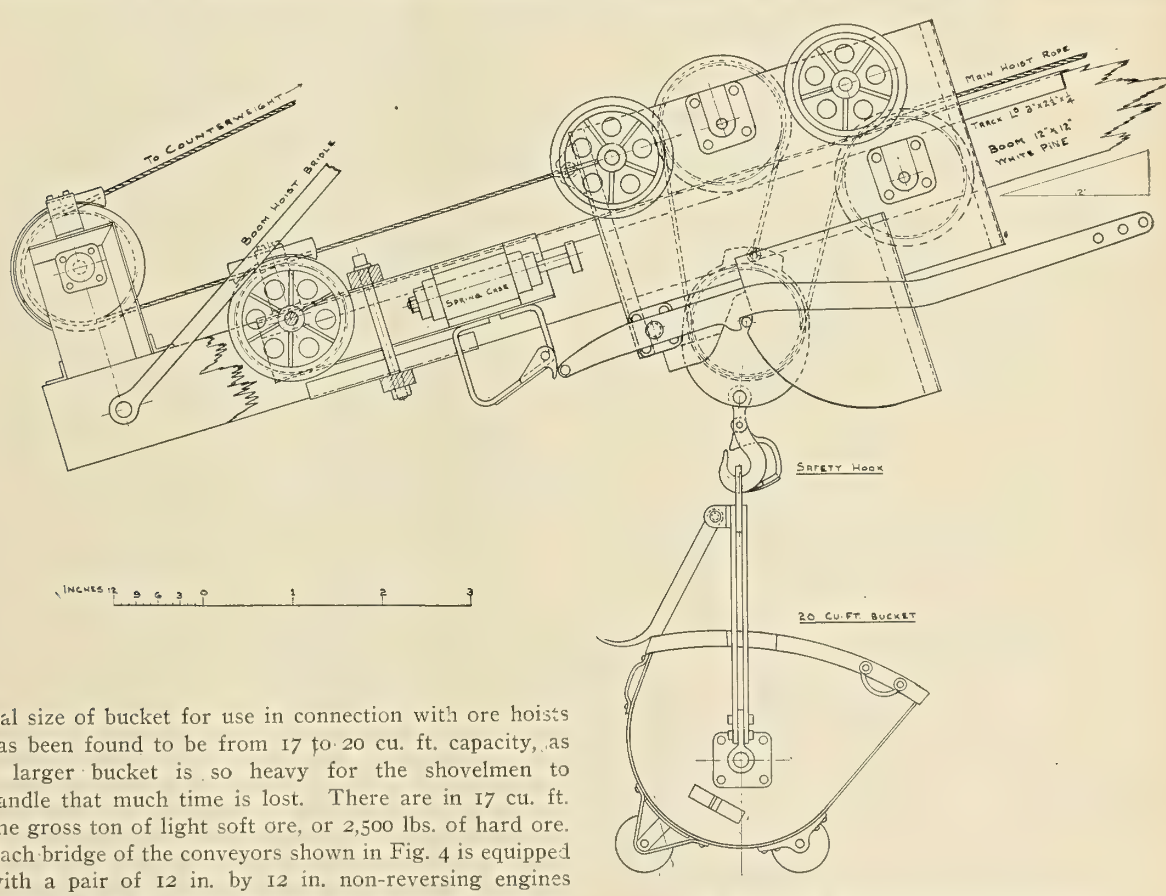


FIG. 5.—DETAIL OF WAGON AND FRONT STOP.

speed of the drum is effective on the wagon, so that a single revolution of the engine carries the wagon 10 ft. 5 in. along the bridge in trolleying, or lifts the bucket 3 ft. 5⅝ in. in hoisting, thus making the machines very quick in action. The incline of the bridge is aided in returning the wagon by a counterweight in the rear tower. The main hoisting ropes are 5-8 in. dia., 1-2 in. ropes having been found too light for the severe service-running on 24 in. sheaves except in the wagon, where they are 17 in. and in the hanging blocks, where they are 14 1-2 in. dia. The engines have auxiliary drums for hoisting the boom or apron that overhangs the boat, and they are also arranged to move the front end of the bridges in or out from the centre bridge in order to accommodate any spacing of hatches, and to propel the front tower along the track parallel to the dock face. The rear towers are moved by a locomotive on a parallel track. The returning wagon is controlled by a band brake on the drum worked by the foot of the operator. These machines have made some remarkable records in point of speed, as an individual wagon has made 50 return trips per hour, carrying the bucket from the bottom of the boat to a point half way between the towers. The best cargo record was 3,241 gross tons taken out in 12 1-2 hours by six bridges. The operator is located in the front tower in these machines, in full view of the hatch, which makes the matter of getting the bucket up and down through the hatch much easier and quicker than when he is further removed from the boat.

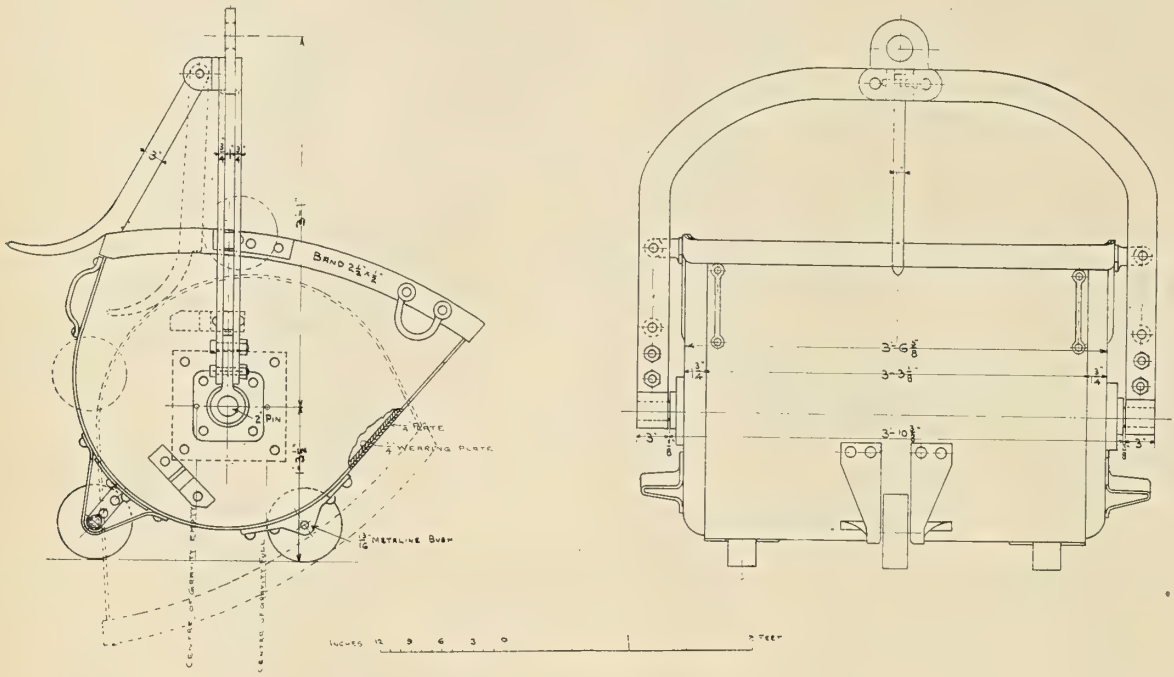


FIG. 6.—DETAIL OF 20 CU. FT. BUCKET FOR MCMYLER UNLOADER AT LORAIN.

In Fig. 7 is shown the type of unloader built by The Brown Hoisting and Conveying Machine Co., the pioneers in the building of dock machinery on the Lakes. It differs from the McMyler hoists already described in the type of towers employed and in the arrangement of the towers. The engines also have a single reduction gearing between the crank shaft and drum, thus using a smaller engine with higher piston speed. The machines are generally arranged in groups of two, with the engines and boilers, and operators in the rear tower. Both towers are generally moved along the dock by hand. There are over 175 bridges of the Brown type of conveyor at the different Lake Erie ports.

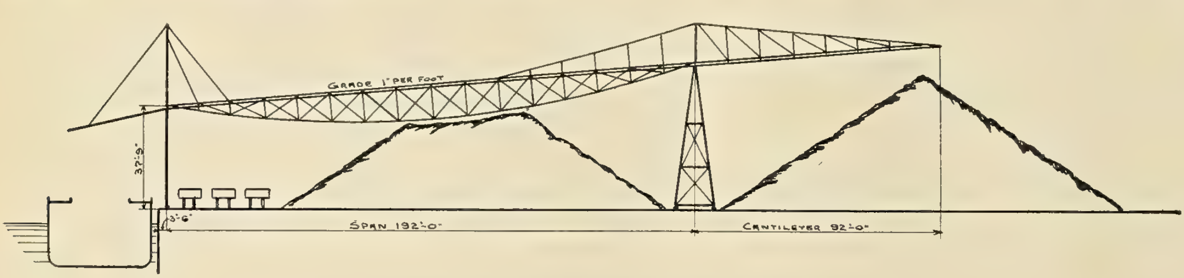


FIG. 7.—BROWN TYPE OF UNLOADER USED ON THE LAKES.

In Fig 8 is shown yet another type of ore unloader built by the King Bridge Company, the distinctive feature being the great freedom of motion of the

bucket. In both the Brown and McMyler type, the hanging block is locked in the wagon and cannot be released without striking a stop which is bolted between the tracks. Thus, when unloading very narrow boats, the front stop on the apron must be moved in until it is vertically over the centre of the hatch; and similarly for loading into a car on a track under the rear cantilever, a stop must be placed over the centre of the track to allow the bucket to be lowered in order to reduce the drop of the ore. In the King machines, however, the bucket can be raised or lowered to any desired height simultaneously with its travel along the bridge. The dock records of Conneaut Harbor show that nothing is lost in point of speed of operation, and considering its advantages, it is surprising that the system has not been used to a much greater extent, its only disadvantage being that three drums and reversing engines are required for its operation.

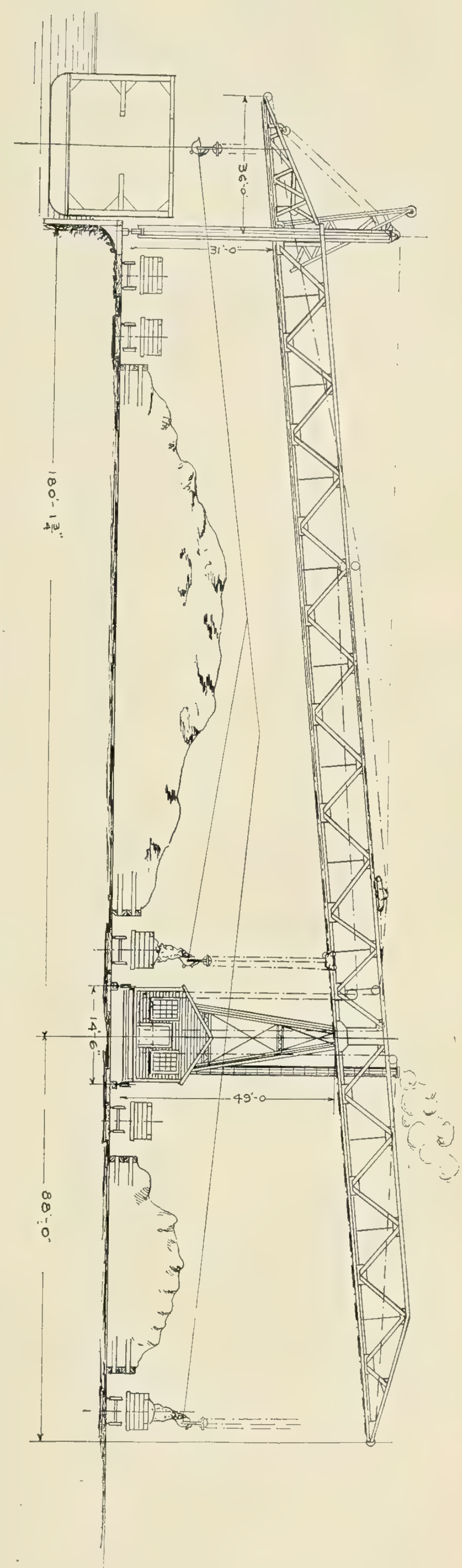


FIG. 8.—TYPE OF ORE UNLOADER BUILT BY THE KING BRIDGE CO., IN USE AT THE CONNEAUT HARBOR ON THE GREAT LAKES.

Changes in Lloyd's Rules for Shafting.

Changes in the rules for determining the dimensions of shafting were recently decided upon by Lloyd's Register and are now in force. The amended paragraphs are referred to by their numbers and are as follows:

SHAFTS.

30. All shafts are to be made of good material and are to be examined when rough turned and when finished. In the case of screw shafts scrap steel is not to be used. It is recommended that these be made of ingot steel or forged from blooms made from rolled iron bar of good fibrous quality.

31. Gauges of an approved description for testing the truth of the crank shafts are to be supplied with all new engines, and adjusted in the presence of the surveyor.

32. The length of the stern bush is to be at least four diameters of the shaft. It is recommended that the shaft liner should be continuous the whole length of the stern tube, and that the after end should be tapered in thickness and made watertight in the propeller boss. If the liner is made in two pieces the joint should be burned. If the liner does not fit tightly at the part between the bearings in the stern tube, the space between the shaft and the liner should be charged or "forced" with a plastic material insoluble in water and non-corrosive. If two liners are used, it is recommended that they be tapered in thickness at the ends, and that the shaft should be lapped or protected between the liners. In this case, and also if no liners are used, the diameter of the shaft should be $\frac{21}{20}$ths of that required for a shaft with a continuous liner.

For dimensions of shafts, see the formula in paragraph 59.

RULES FOR DETERMINING SIZES OF SHAFTS.

59. The diameters of intermediate shafts are to be not less than those given by the following formula:

For compound engines with two cranks at right angles:

Diameter of intermediate shaft in inches =

$$(\cdot 04\,\mathbf{A} + \cdot 006\,\mathbf{D} + \cdot 02\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$$

For triple expansion engines with three cranks at equal angles:

Diameter of intermediate shaft in inches =

$$(\cdot 038\,\mathbf{A} + \cdot 009\,\mathbf{B} + \cdot 002\,\mathbf{D} + \cdot 0165\,\mathbf{S}) \times \sqrt[3]{\mathbf{P}}$$

For quadruple expansion engines with two cranks at right angles:

Diameter of intermediate shaft in inches =
$(\cdot034\,\mathbf{A} + \cdot011\,\mathbf{B} + \cdot004\,\mathbf{C} + \cdot0014\,\mathbf{D} + \cdot016\,\mathbf{S})$
$\times \sqrt[3]{\mathbf{P}}$

For quadruple expansion engines with three cranks:
Diameter of intermediate shaft in inches =
$(\cdot028\,\mathbf{A} + \cdot014\,\mathbf{B} + \cdot006\,\mathbf{C} + \cdot0017\,\mathbf{D} + \cdot015\,\mathbf{S})$
$\times \sqrt[3]{\mathbf{P}}$

For quadruple expansion engines with four cranks:
Diameter of intermediate shaft in inches =
$(\cdot033\,\mathbf{A} + \cdot01\,\mathbf{B} + \cdot004\,\mathbf{C} + \cdot0013\,\mathbf{D} + \cdot0155\,\mathbf{S})$
$\times \sqrt[3]{\mathbf{P}}$

where **A** = diameter of high pressure cylinder in inches,
B = diameter of first intermediate cylinder in inches,
C = diameter of second intermediate cylinder in inches,
D = diameter of low pressure cylinder in inches,
S = Stroke of pistons in inches,
P = Boiler pressure above atmosphere in lbs. per square inch.

60. The diameter of crank shaft and of thrust shaft under the collars, to be at least $\frac{21}{20}$ths of that of the intermediate shaft. The diameter of thrust shaft may be tapered off at each end to the same size as that of the intermediate shaft.

61. The diameter of the screw shaft to be equal to the diameter of intermediate shaft (found as above) multiplied by $\left(\cdot63 + \frac{\cdot03\,\mathbf{P}}{\mathbf{T}}\right)$, but in no case to be less than $1\cdot07$ **T**,
where **P** is the diameter of propeller, and
T the diameter of intermediate shaft, both in inches.

This size of screw shaft is intended to apply to shafts fitted with continuous liners the whole length of the stern tube, as provided for in paragraph 32. If no liners are used, or if two separate liners are used, the diameter of the shaft should be $\frac{21}{20}$ ths that given above.

The diameter of screw shaft is to be tapered off at the forward end to the size of the crank shaft.

62. Note.—The rules are intended to apply to two-cylinder compound engines, in which the ratio of areas of low and high pressure cylinders does not exceed 4.5 to 1; the triple expansion engines in which it does not exceed 9 to 1; in quadruple expansion engines in which it does not exceed 12 to 1; and in all cases, as regards the stroke, in which the length of stroke is not less than one-half the diameter or greater than the diameter of the low-pressure cylinder. Engines of extreme proportions beyond these limits being specially submitted to be dealt with on their merits.

PERIODICAL SURVEYS.

65. The stern shaft is to be examined annually and drawn at intervals of not more than two years.*

These new rules are the result of a long continued investigation made by the technical committee of Lloyds.

* On the application of owners, the Committee will be prepared to give consideration to the circumstances of any special case.

DIRECT APPLICATION OF ELECTRICITY TO THE PROPULSION OF SHIPS.

A Reply to Certain of the Statements Made by Nikola Tesla in the June, 1900, Issue of "The Century Magazine."

BY WILLIAM F. DURAND.

In the June number of *The Century Magazine* is found an article from the pen of Mr. Nikola Tesla, in which the author discusses in a decidedly transcendental manner the problem of "increasing human energy." It would not be difficult to join issue with Mr. Tesla regarding some of the fundamental assumptions made, as for example, that *mechanical energy,* expressible by formula $MV^2 \div 2$, or in terms of mass and velocity as we know them, can fully represent the quality of the operations of the human mind. This is simply begging a question regarding which we are profoundly ignorant, a question regarding which we have no sure facts, and therefore in regard to which it is in the last degree unscientific to make the assumptions implied by the author.

The chief interest lies, however, with the transcendental and hypothetical conclusions drawn from these assumptions, and among them are found two or three relative to the application of electricity to marine propulsion. These conclusions are utterly incorrect and in direct antagonism with the laws of nature, and taking into account the standing in literary circles usually accredited to *The Century Magazine* and the popular reputation as an electrician usually accredited to the author, it would seem proper to point out the nature of these errors, lest by those not technically qualified to judge, such absurdities might be considered as having some foundation in fact.

On page 198 are found the following statements:

> Instead of driving the machinery in a factory in the old wasteful way by belts and shafting, we generate electricity by steam power and operate electric motors. In this manner it is not uncommon to obtain two or three times as much effective motive power from the fuel, besides securing many other important advantages. It is in this field as much as in the transmission of energy to great distances that the alternating system, with its ideally simple machinery, is bringing about an industrial revolution. But in many lines this progress has not yet been felt. For example, steamers and trains are still being propelled by the direct application of steam power to shafts and axles. A much greater percentage of the heat-energy of the fuel could be transformed in motive energy by using, in place of the adopted marine engines and locomotives, dynamos driven by specially designed high-pressure steam or gas-engines, and by utilizing the electricity generated for propulsion. A gain of fifty to one hundred per cent in the effective energy derived from the coal could be secured in this manner. It is difficult to understand why a fact so plain and obvious is

not receiving more attention from engineers. In ocean steamers such an improvement would be particularly desirable, as it would do away with noise and increase materially the speed and the carrying capacity of the liners.

It is more especially with respect to the latter part of the quotation that we are here concerned. The proposition in brief is to displace the usual type of marine engine by "specially designed high-pressure steam or gas engines," driving electric generators, the electrical energy thus developed being then carried to an electric motor attached to the propeller shaft. In other words, an electric generator and motor are to be interposed between the engine and the propeller-shaft. Now let us examine this proposition, regarding the likelihood of an increase of efficiency similar to that promised in the quotation given above.

In the first place not the slightest grain of superiority or improvement in efficiency due to the use of the "specially designed high-pressure steam or gas engine will be conceded. Any such motor which can be used to operate an electric generator can also be used to operate a propeller direct, and without the interposition of the generator and motor. Screw propellers are designed and operated at speeds of revolution from 100 per minute and less to 2,000 per minute and over, and as an instrument of propulsion it is as fully capable of utilizing any gain in the efficiency of the prime-mover as is an electric generator. In any event the use of a screw propeller is assumed, and it is evident that it will be an element of equal value in either scheme of powering and propulsion.

Further, as to the high pressure steam engine, where shall we find anything higher than the 300 to 400 lbs., which is accepted and involved in present day practice with torpedo boats, fast launches, yachts and cruisers? Again, with regard to engine efficiency, where in present practice shall we go to better the record of the S. S. *Kensington*, 8,000 I. H. P., with her service record of about 1.00 lb. of coal per I. H. P. for the main engines? Again, regarding gas engines on board ship, the weight which present practice seems to find necessary for their safe construction and efficient operation is entirely prohibitive of their use when the highest results are to be attained. Then as a practical problem how would a designer of gas engines like to undertake the design and guarantee performance of a gas engine of, say, 10,000 I. H. P.? Or if, otherwise, such total power were to be split up into a number of small units the whole scheme immediately breaks down by reason of its complexity and weight. Then there is the further question of the cost of gasoline or other hydrocarbon, and of the enormous increase of output which would be required in order to make possible its use on any large scale; or if the gas is to be made from coal, is each ship to carry gas works in the fore hold, or is the gas to be stored in the bunkers and double bottoms?

All these considerations of detail, however, are beside the main point, which, as already noted, is that no claim of superiority whatever can be admitted for the use of any special type of prime-mover, since for utilizing the increased efficiency of any such improved steam or gas engine, the propeller is quite as capable as the electric generator.

The question simplifies therefore to the following: Given two steam engines or other prime-movers of equal efficiency, to compare the two schemes for ship propulsion in one of which the prime-mover is attached directly to the propeller shaft; and in the other, of which there is interposed between the two an electric generator and motor. If the gain of from 50 to 100 per cent promised by Mr. Tesla is to be realized at all, it must therefore come in as a result of these additional transformations of energy. Now, one of the first things which the engineer learns in his dealings with energy is that all transformations are sources of loss. This is a fact so simple and so fundamental that it cannot be overlooked, least of all by one who has given his life to the study of problems involving the transformation and use of energy in various forms. Yet here we find a proposition to interpose between the steam engine and the propeller two transformations or changes of energy, one from the mechanical form in the engine to the electrical form in the generator, and the other a change back to the mechanical form in the motor. There will also be a further loss due to transmission from the generator to the motor, but on board ship this will be very small and may be neglected. Taking as a basis of estimate the actual achievements of electrical engineering at the present day, the best combined efficiency which could be expected for this double transformation would be perhaps 90 per cent, though probably 85 per cent might be a safer estimate. In other words, of the energy supplied by the steam engine from 10 to 15 per cent would be lost as a result of the electrical transformations. So to take the more favorable case, for every 100 horse power delivered by the engine, 90 will reach the shaft instead of 100 as in the case of direct connection between engine and propeller. Yet to these transformations of energy which by the law of the conservation of energy must result in a loss, we are to look, if anywhere, for a gain of from 50 to 100 per cent, so that in the preceding case instead of 90 delivered horse power or thereabouts, as would actually be the case, we are to look for from 150 to 200. This would mean simply the creation of energy, and is a dream of perpetual motion in its baldest form. Such a proposition is a not unworthy fellow to those which have but recently been put before the public in connection with the liquid air absurdities.

Mr. Tesla knows, however, too well the doctrine of the conservation of energy to base any expectation of gain upon transformations which he knows must give rise to a loss, and it is therefore only fair to assume that his faith was pinned to the gain expected from the "specially designed high-pressure steam or gas engine," a gain which would reduce the cost of power in terms of fuel to one-half or two-thirds of the figures representing the best present practice. This especially designed engine would apparently also be of such peculiar type that while available for operating an electrical generator it could not be used for turning a screw-propeller. It may perhaps be in order to suggest that the design for such a prime-mover should be forthcoming in order to substantiate the claim, and until such an engine is produced all such claims for possible gain must be considered as without foundation, and instead of gain there is the certainty of loss. There may also have been some

expectation of gain by a shortening of the line shafting, or in greater uniformity of turning effort in the propeller. There is ground for expecting small gains due to these features, but so small as to be utterly inconsiderable and without practical influence on the main features of the problem. These points only merit mention in order that all sources of gain for the electrical scheme may be noted.

The author's naive curiosity as to why a method which promises so great a saving should have received so little attention from engineers is at the least amusing. Does he suppose that marine engineers are ignorant of the trend of advancement in the electrical field? Does he suppose that if there were any reasonable hope of increasing the efficiency by 50 to 100 per cent that it would not receive some attention from those most interested? If there were any likelihood of cutting the consumption of coal per day on a "liner" from, say, 400 tons to 200 or 275; that is a saving from 125 to 200 tons per day, and of increasing the cargo capacity by perhaps 1,000 tons for the trip, would those most interested long delay the adoption of such means? The truth seems to be that this so-called "fact," plain and obvious as it may seem to Mr. Tesla, is less plain and less obvious to those who are actually doing the world's work in the field of marine design and construction. If there is any one fact that is plain and obvious to them it is that a multiplication of changes of energy means a loss, and the proposition to interpose additional changes between the prime-mover and the propeller will be apt to receive from them small consideration so long as the laws of nature remain as they now are.

There is still another interesting side to this proposition, and that is, the price which must be paid for the apparatus; that is, for the generators and motors. The first point to be made is that the price is two-fold; one the price in terms of money, and the other the price in terms of weight.

If we confine ourselves to actual achievement in electrical engineering we shall hardly find builders of generators and motors ready to guarantee results for much less than 20 to 30 lb. per H. P., and these figures will require most careful design and might easily rise to 50 lb. and over. The installation of generators and motors will therefore mean the addition of, say, 50 lb. and upward per H. P. This would just about double the weight of machinery on a modern torpedo boat, for which in recent practice the engines and boilers together weigh 50 lb. or less per I. H. P. Let us compare the figures for a torpedo boat with 3,000 I. H. P.:

	STEAM EQUIPMENT.	STEAM AND ELECTRICAL EQUIPMENT.
Hull	56 tons	56 tons.
Coal, ordnance and stores	37 "	37 "
Machinery	67 "	134 "
Total	160	227

The displacement of the boat would thus be increased by about 67 tons, or from 160 to 227, while the power delivered to the propeller shaft would be decreased by, say, 300 H. P. The joint effect of these would be a reduction in the speed of the boat by about 3 knots, or from, say, 25 knots to 22. These results are hardly such as would be apt to commend themselves to naval designers.

Again, with a "liner" having, say, 25,000 I. H. P., the addition of electrical machinery of suitable type would result in adding perhaps 1,500,000 lb., or about 700 tons to the machinery weights. For the same total displacement this would mean the loss of about 700 tons of paying cargo, and a further loss of about 2,500 horse power as a result of the electrical transformations, decreasing the speed by from 1-2 to 3-4 knot. When we remember that on the modern "liner" the margin of weight left for paying cargo is quite small, usually not exceeding a maximum of 2,000 tons, it is apparent that the loss of 700 tons or more would result in a most serious reduction in the earning capacity of the vessel. The "increase" of carrying capacity referred to at the close of the quotation would be therefore of a character not likely to commend itself to the stockholders or board of directors.

The price to be paid in cash will depend on the current prices for electrical machinery of such types and sizes as may be required, but it will not be far wrong to say that the cost of the electrical equipment would be not less than that of the steam equipment, and that the cost of the total equipment would therefore be not less than double what it is with the present methods of powering and propulsion. The interest on this added first cost would make a most serious inroad upon the small margin of profit now obtainable from investments in this field of commerce.

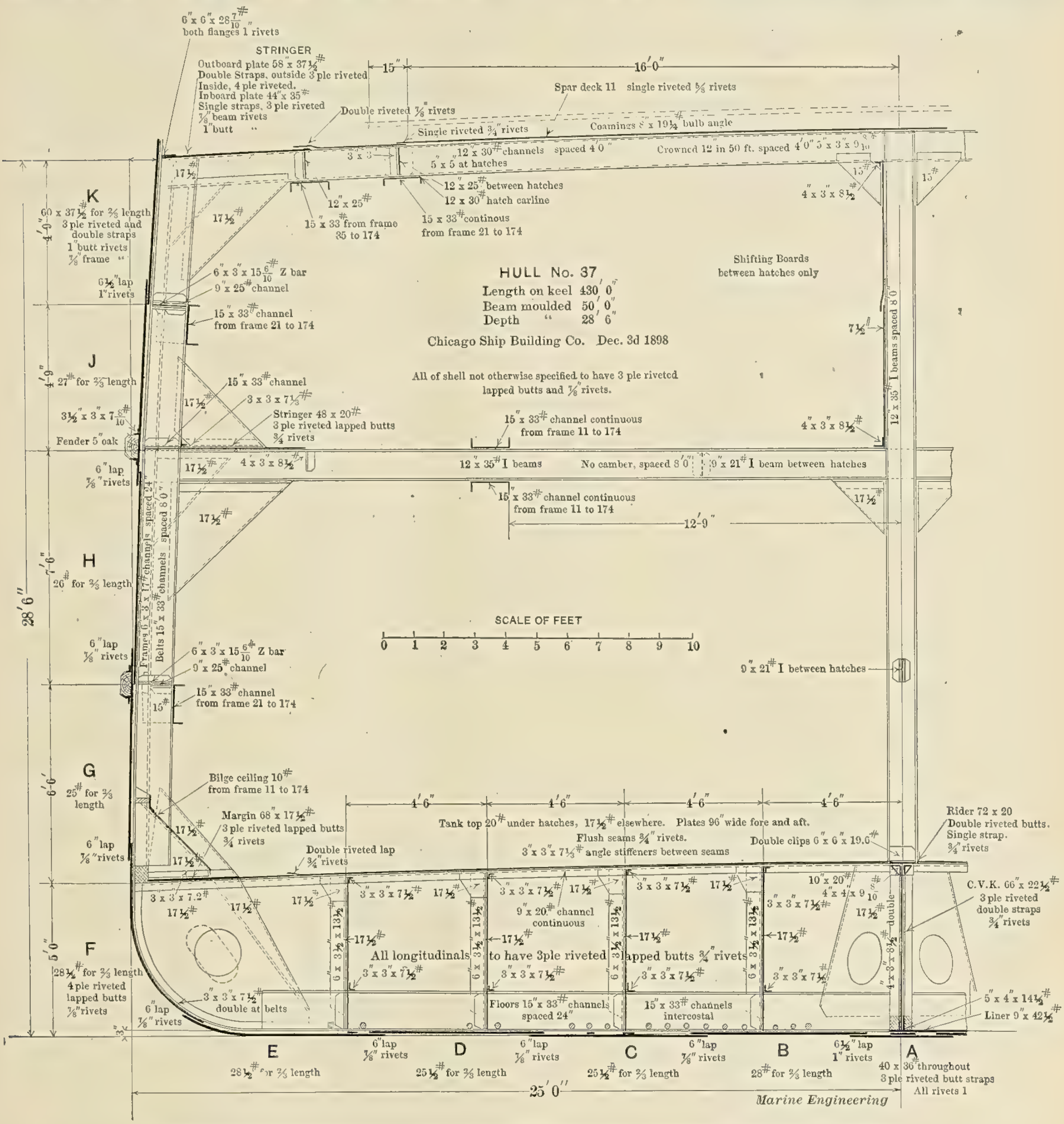
A passing reference may also be made to the statements in the early part of the quotation relating to the substitution of electric generators and motors for lines of shafting and belting, whereby it is claimed that two or three times as much effective power may be obtained as by the old and wasteful methods. From what has preceded it is clear that the substitution of electric generators and motors for shafting and belting is a substitution of one form of loss for another, and the final balance will depend on which is the greater of the two. If the belting and shafting scheme is long and complicated and perhaps in poor mechanical condition as well, there will undoubtedly result a gain in efficiency for the electrical scheme. If it is short and direct and in good condition, the advantage will remain with the mechanical transmission. In no normal or ordinary case, however, will the gain amount to anything approaching 100 to 200 per cent. In fact, the question of fuel economy in such cases is only one of many considerations, and not always the most important. In cases where such installations have been made it is probable that other considerations have weighed quite as much as that of economy of fuel. Among such special advantages for the electrical scheme are the following: Independence of operation, entire freedom in locating machines without reference to lines of shafting, etc., absence of line shafting, countershafts, etc., and consequent greater freedom for the operation of cranes and handling gear.

Russian Cruiser Variag.—A builders' trial of the Russian cruiser *Variag*, built at Cramps', Philadelphia, was carried out last month. With about 150 engine revolutions (17,000 I. H. P.) a speed of 22 knots was reported to have been attained, natural draft.

SYSTEM OF WORK ADOPTED IN A SHIPYARD ON THE GREAT LAKES—II.*

BY W. I. BABCOCK.

All the work is now carefully bolted, reamed by pneumatic drills, and is ready for riveting, which is started at once amidships by pneumatic yoke riveters for the inside and by pneumatic shell riveters for the bottom plating, nearly all the rivets in the hull being machine driven. As soon as the channel seam straps punched, rolled, and bolted up in position. That these plates are not gotten out from moulds like the others is principally because the very careful work on a surface of so sharp a curve is too expensive. At the lapped butts it is evident that the radius is greater for the outside plate than for the inside, and in any rolled plate the necessary difference between the lengths of the two surfaces is obtained sometimes by compression on the inside and sometimes by extension on the outside, and there is no way of determining beforehand which will



HALF CROSS SECTION OF S. S. MAUNA LOA—TYPICAL LAKE FREIGHTER FOR BULK CARGOES.

and ties are riveted to the bilge brackets, the tank margin plates are put on and the angle on top of same for the bracket connections, and all riveted.

The bilge plates are now templeted from the work, occur. Further than this comes in the slight irregularity in the height of the floor ribbands, the effect of which is magnified at the bilges, increasing the chance of bad holes and spoiled plate. While the use of this mould system requires in any event a good solid foundation under the ship, it must be remembered that this is

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.

only piling; that shores and blocking are of wood, only roughly cut to length and wedged up; and that ribbands are also of wood, supported only at intervals, and lined up principally by a ship's carpenter's eye. While our experience has amply proven that for such parts of the bottom as have been already described—all straight work—these sources of error are quite negligible, that is not so with the bilge plates, even amidships, and it is much cheaper to templet these plates than to spend the time and money necessary to bring the framework of the tank to such perfection of outline and spacing that mould work could be depended upon in all cases.

With the bilge plates in place, the water bottom for the straight midship body of the ship is completed. The remainder of the shell plating within the limits of the water bottom, the margin plates and other plates of the tank top are templeted off in the ordinary manner.

In the meantime, the channel frames and belts for the sides of the ship above the tank for the straight midship body and for some distance forward and aft of same—until the curvature becomes too great and beveling commences—have been cambered cold in a heavy power bending press. These frames and belts having been ordered to lengths taken directly from the mould-loft floor, the variation in length is very slight from what is actually required, and is taken up at the lower ends, which stop about 4 in. short of the margin plate of tank to form a water-way. The main-deck line and side stringers, and the plate edges of all side strakes, are run in parallel to the upper deck sheer. One mould for the web and one for each flange of frames and bolts, therefore, answer for all holes down to and including the lower side stringer. The holes at the bottom for the rivets connecting the channel frame or belt to the tank-top bracket are put on from the same mould, but as these holes are set to a level line, which is the height of the top of the center vertical keelson, the mould must be moved down at each frame a distance equal to the raise of the sheer at that frame, these sheer heights of spar deck being marked on the upper end of the mould.

The spar-deck beam brackets and the main-deck lower brackets are now laid out, each from its own mould, for all that part of the ship for which the tumble-home is constant, punched, bolted on to the frames and belts, and riveted by the stationary riveter. The spar-deck beams are cambered and, with the straight main-deck beams, stanchions, shifting boards, channel ties and struts and 'thwartship hatch coamings, laid out from moulds and punched. Side stringer channels, which are in short lengths between belts, and Z-bar clips between frames are laid out, punched and riveted together on the ground by portable yoke riveters. Main-deck stringers for the straight body are laid out and punched, with the channel intercostal to the skin between belts, which is scored out to allow the frames to pass through.

The three upper strakes of the side plating for the straight side are now laid out, punched, and countersunk. For the lowest of the three, the maindeck sheer, this does not include any more plates than those on the midship body, as the frame line begins to leave the tumble-home line at its lower end immediately the extremities of the dead flat are passed, the point of departure going higher with each frame. The between-deck strake has a larger number of plates on the flat side and the sheer strake the most of all. For laying out these shell plates a slip mould is used. I believe that this method of laying out side plating is original with Superintendent E. Gunnell, of the Chicago Ship Building Co., to whom, in fact, most of the development of the system is due.

This mould is based on the principle of working from a level line parallel to the keel of the ship. The mould itself is square, the length inside of the end pieces being the exact length of the plate. At about its center a straight line is marked across it. The frame strips and butt lap moulds are entirely separate from the main mould and have similar lines marked upon them, one butt mould having in addition a scale of inches marked on it, starting from the line at zero. The fitter is furnished with a table, prepared for the mould-loft floor, showing the sheer height of the spar-deck line at each butt.

The squaring mould is now placed on the plate, the line on one butt mould brought into exact accordance with the line on one end of it, and the other butt mould raised until its line is a distance above the level line on the squaring mould equal to the raise in the sheer from the table. A chalk line is then stretched between the two ends, snapped on, and the mark on each frame strip brought exactly to it. All the frame and butt holes are now transferred to the plate and the moulds are removed. When the seam lap moulds, or, in the case illustrated of a sheer-strake plate, the gunwale mould for the upper edge, have been put on and the holes marked the plate is ready for punching and countersinking.

If the sheer of the ship is so bold that the variation from the straight line in the length of a plate must be taken into account, it is only necessary to use the exact sheer height at each frame in setting the frame strips, but this seldom happens.

There is now a large portion of the hull of the ship above the tank ready for erection, and it is assumed that sufficient of the water bottom, if not all of it, is completed and riveted, for a start to be made on the upper work. The water bottom or tank now forms a broad, solid foundation on which the remainder of the framing is erected, requiring no side shores whatever until the very extremities of the ship are reached. Evidently, however, as so much of the upper works have been laid out from moulds, any inequalities, however slight, in the tank must be corrected before this erection is started, otherwise bad work will result and the various pieces will not come together correctly.

For this purpose a line is leveled across the top of the center vertical keelson and marked on the inside of the bilge plates above the tank, corresponding to the line from which the side frames and belts were punched, referred to previously. The frame and belt brackets are now placed in position between the angles on the tank-top margin plates and the position of this level line transferred directly to them, and at the same time the bottom holes are marked from the angles. The bracket plates are then take to the shop and the remaining holes for the frame and belt rivets marked off from the moulds which were used for the corresponding holes in the frames and belts. As these moulds in each case are set from the level line spots referred to, it is evident that when the brackets are put back in position on the ship

and the frames and belts bolted thereto, their tops will come true to the spar-deck line independent of high or low points in the tank margin itself, and, therefore, the main-deck line, stringers, and plate edges will also come true.

The belt, stanchions, and main-deck beams are now erected by the overhead crane, leveled, plumbed, and squared up, the whole making a self-contained structure. The sheer strake is then bolted into place and the frames put up. As soon as the shifting boards, bulkheads, and main-deck stringers and ties are in place, the spar-deck heads are put in and the shell plating bolted up with the upper and lower side stringers. The spar-deck plating between hatches which had previously been punched from moulds (corresponding plates in each space being exactly alike, except for manholes, mast holes, etc.) is now put in place, as well as the channel ties and intercostals under and between the spar-deck beams, and the athwartship hatch coamings. When all bolted and reamed a large amount of work, both inside and shell, is opening up for the machine riveters. The remaining strake of side plating amidships, that immediately above the bilge, is now templeted off the ship, thus eliminating the effect of any variations in the height of the tank margin.

The above description includes about all of the ship which is gotten out by what may be called duplicate mould work. The remainder of the framing at the ends, etc., is laid out, furnaced and punched from ordinary individual wooden moulds, and the plates, stringers, etc., templeted off the work in the usual manner. No scrieve board is used.

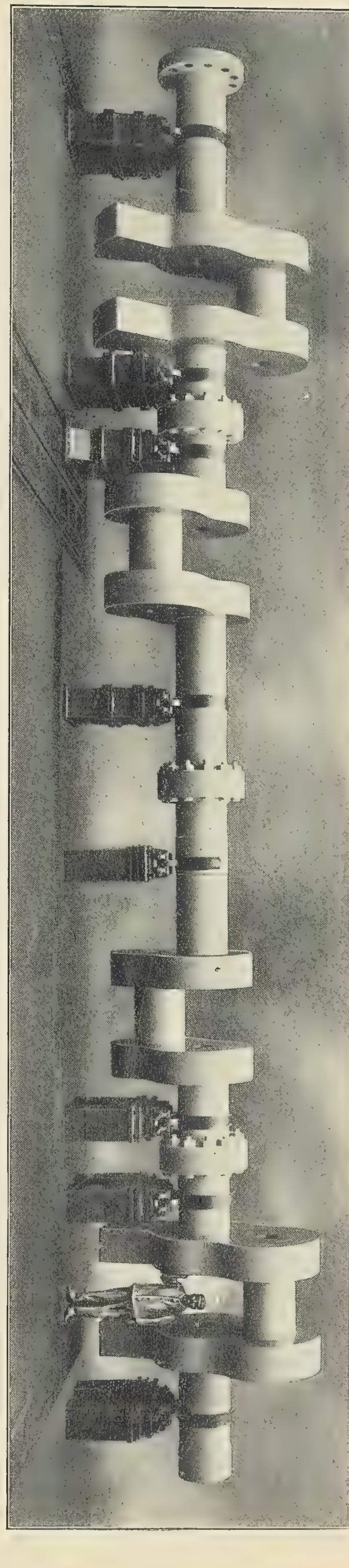
In general, it may be said that the system used in the Chicago yard requires very careful work in the mould loft, explicit directions to the foreman in charge of each ship, and a thoroughly competent and experienced superintendent in actual charge of the yard to harmonize the work of the various shop and outside foremen and to decide where duplicate work shall stop and a return be made to ordinary methods.

This is principally a matter of cost in every case. If too much time and labor is required to bring certain portions of the structure to such exact accordance with the mould-loft floor, that other portions following them, laid out from moulds, made from the floor, will go exactly into place, it is cheaper to follow ordinary methods, where a much greater variation is allowable, because each piece is based only on the piece next ahead of it, and, therefore, errors are not cumulative.

As a matter of personal opinion, however, after an experience covering the construction of some thirty ships of large size under the mould system, the writer thoroughly believes that this system is the cheapest known and can be applied to a large extent with great advantage in any yard where large ships are built, of any type.

While docking at Newport, R. I., the torpedo boat *Dupont* attempted to ram a wharf and was badly damaged forward, her bows being crushed in. A defect in the engine telegraph is said to have been the cause.

Admiral Ahmed Pacha, of the Turkish Navy, is now in this country, presumably for the purpose of placing an order for a warship here.



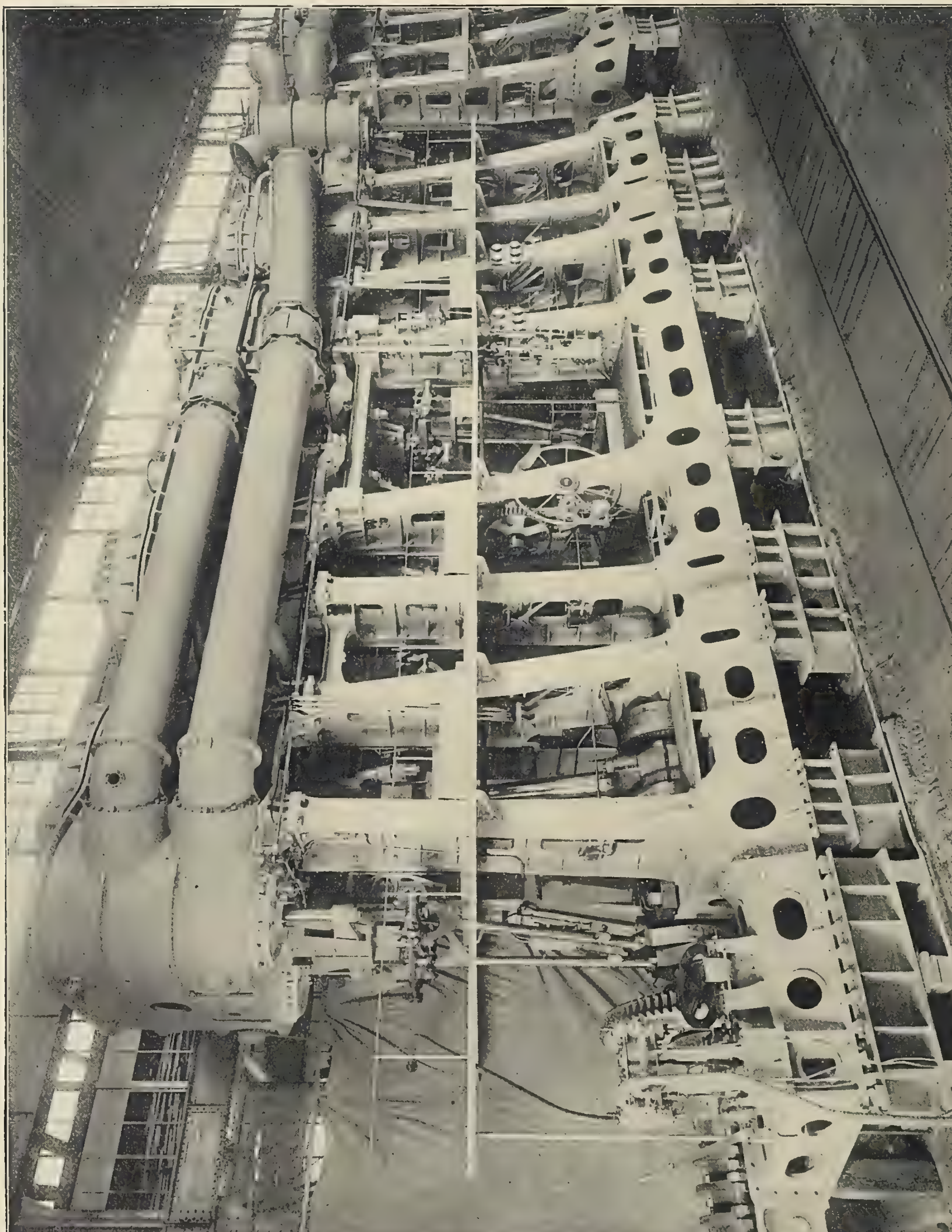
ONE OF THE NICKEL-STEEL CRANK SHAFTS OF THE NEW HAMBURG-AMERICAN LINER DEUTSCHLAND—NOTE COMPARATIVE SIZE OF MAN AT FORWARD CRANK.

Hamburg-American T. S. S. Deutschland.

Owing to an unlooked for and regrettable mishap, the Hamburg-American liner *Deutschland* did not start on her maiden voyage June 17 as had been intended. Early in the month while on her way down the River Oder, from the builder's yard at Bredow to Swinemunde, preparatory to a trial run in the Baltic, she went aground in the channel. Assistance was promptly rendered by salvage companies and by the German coast defence vessels *Aegir* and *Odin*, which were ordered to her aid. Dredges were put to work to make a channel, and increased buoy-

ancy was secured by the use of pontoons, so that by June 13 she was afloat again. Before reaching the sea, however, she went aground again and another delay was caused, the vessel not reaching Swinemunde until after the middle of the month. From there it was reported she would proceed to Hamburg by the outside route, being too large a vessel to go through the Kiel canal, and, all going well, would sail for New York July 5. As the bottom where the vessel grounded was chiefly mud, it is not believed that she has sustained any structural damage.

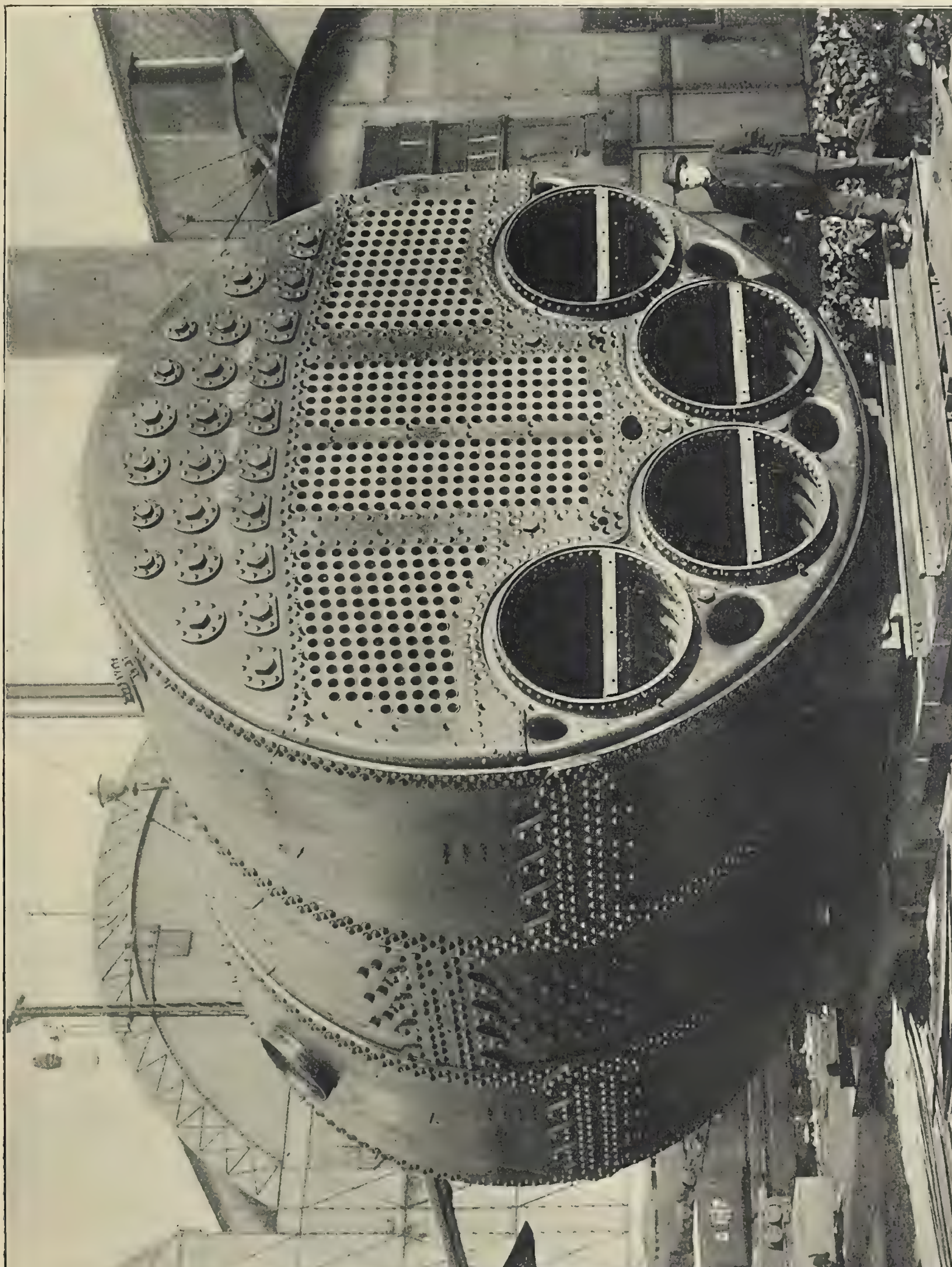
Through the courtesy of the American managers of the line we are able to here present reproductions of original photographs of the machinery of the new vessel. In our issue last month we gave the chief dimensions of the main engines. As will be recalled



SIX-CYLINDER, FOUR-CRANK QUADRUPLE EXPANSION ENGINES OF T. S. S. DEUTSCHLAND—NOTE H. P. TANDEM CYLINDERS ARE NOT IN PLACE.

they are of the six cylinder, four crank, quadruple expansion type, with the two high pressure and the two low pressure cylinders tandem in the center and the two intermediate pressure cylinders at the ends.

which to set up the high pressure cylinders in position. The position of the H. P. cylinders in the completed engine can be located by noting the beds for their reception on the tops of the L. P. cylinders. The photograph gives no adequate idea of their size, as there is nothing in the picture with which to make a comparison. It is usual in a case of this sort to include a man in the view, so that in this way a rough estimate



ONE OF THE DOUBLE-ENDED 8-FURNACE MULTI-TUBULAR RETURN TUBE BOILERS OF THE NEW TRANSATLANTIC LINER DEUTSCHLAND.

These engines—each set of about 16,500 I. H. P.—were a big job even for a large shop like the Vulcan Works, and as they were not erected in pits there was not sufficient head room under the traveling cranes in

can be made of general dimensions. This result has been secured, however, in the case of both the boiler and the crank shaft, in the latter view the relative size of the man and one crank, even, gives a better idea of the immensity of these engines, though they are not as huge as engines of this power would have been in the old days of the tandem compound. Each crank shaft is hollow, in four sections, of the built up type with counterbalances on the I. P. cranks. Each is made of nickel steel and is a magnificent specimen of forging of these dimensions: length 59 ft. 3 3-8 in., outside dia., 25.2 in., length of throw 36.42 in., weight (22,330 lb.) close to 100 tons. By comparing the dimensions of the crank with those of the workman in the photograph a proper realization of its dimensions is possible, and then by mentally transferring these to the general view of the engines the actual sizes can be properly appreciated. Nickel steel is also used for the propeller shaft, and the intermediate shafting is of Siemens-Martin steel.

There are twelve double ended and four single ended Scotch boilers in the vessel contained in four separate boiler compartments. The boiler shown in the engraving is one of the double ended type, with eight furnaces. It is 16.16 ft. dia. and 20 ft. long, and the diameter of each furnace is 3.6 ft. The boilers are constructed to withstand a working pressure of 225 lb. per sq. in. The total number of fires is 112, grate surface, 2,188 sq. ft.; heating surface, 85,465 sq. ft. Howden draft is fitted.

Log of S. S. Oceanic.

A interesting feature of that most complete record of vessel movements, *The New York Maritime Register*, is the abstracts of steamships' logs published in its pages. From these we here reproduce the log of the White Star liner *Oceanic* on a recent westward trip as follows:

OCEANIC.

From Liverpool May 30, 4.34 PM left the Stage, 8.31 Rock Lt H abeam; May 31, 9.30 AM left Queenstown, 10.08 Daunts Rock lightvessel abeam.

Date.	Wind.	Lat.	Lon.	Dis.	Remarks.
May 31	Variable	51 25	9 22	45	Light Variable winds, smooth sea, fine weather
June 1	Variable	49 56	22 55	524	do do do
2	Variable	47 01	34 49	505	Gentle breeze, SW swell, fine weather
3	Variable	42 50	45 21	512	Light variable airs, heavy rain, fresh breeze, cloudy
4	SW, Var.	41 25	56 03	492	Mod. breeze, foggy, reduced speed, rain, clear weather
5	Variable	40 41	67 12	507	Light airs, smooth and clear, thence misty weather
		To Sandy Hook Lt V		303	June 6, 2.55 AM Sandy Hook Lt V abeam

The steaming time from Roches Point to Sandy Hook was 5 days 21 hours, and 47 minutes, and the course covered 2,888 knots. This is about an hour behind her best previous westward run. The speed average is 20.37 knots, and the best daily run, as shown in the log, 524 knots.

Superimposed Turrets.—Owing to the difference of opinion among the chiefs who form the Naval Board on Construction at Washington, as to the adoption of the superimposed turret for new battleship designs, a special investigation of the question by a board of naval officers was ordered. The result is that a compromise is proposed so that in future designs both systems of placing guns on a ship will be used. This result is highly unsatisfactory, as it is not an answer to the claims of superiority for either system.

A FEW SUGGESTIONS ON THE USE AND ABUSE OF LUBRICANTS.

BY C. GOING.

In the successful operation of modern marine machinery the judicious and economical distribution of the lubricating materials necessary to reduce the friction of the moving parts, forms an important factor. This is a subject upon which there exists as great a diversity of opinion as can be found anywhere; probably no two sea-going engineers can or will agree as to the kind of lubricants to be used, nor as to the methods of applying them. In this brief article it is the intention of the writer to dwell only upon a few points which have come under his observation. Probably the most important branch of the subject is the question of economy. The advent of the modern multiple expansion engine has caused greater attention to be paid by designers to automatic devices for distributing lubricants.

The up-to-date marine engine can, at moderate speeds, run without any oil being applied by hand, and therein lies, in my opinion, one of the greatest disadvantages of the system. While automatic lubrication is undoubtedly a necessity for fast running engines, too much dependence is placed upon this method while running at moderate speed. On Government vessels particularly, where fully nine-tenths of the cruising is at an economical speed, the consumption of oil is an important item. Relying to a great extent upon the automatic devices provided for maximum conditions, no matter how finely the feeders may be adjusted, it will be found that the quantity of oil consumed will be greatly in excess of that used by careful oilers, applying it by hand. I have an instance in mind of a vessel to which I was once attached, where the allowance of oil was ten quarts per watch of four hours, for all machinery in operation. Owing to head winds and stormy weather, which greatly reduced the speed, it was found that at the rate of using oil, the supply on hand would last only three days, whereas under the most favorable conditions it would take at least five days to reach our destination. As the existing oil allowance was considered to be as low as was consistent with safe running, this scarcity of oil became a very serious problem. After a consultation it was decided to shut off all automatic lubricators except the telescopic oilers for the crank pins. The engine room force was warned to be particularly vigilant, and to exercise the most rigid economy in the use of lubricants. As a result, the amount of oil used was reduced to just one-half the former allowance, and that, too, without a suspicion of a hot bearing. In subsequent cruising these regulations were kept up, with

the result that large quantities of oil and other lubricants were saved.

The average oiler is prone to place too much reliance upon self-feeding devices, and as a result, becomes lax in his attention to the journals. If he is compelled to oil by hand while running at moderate speeds, he will be much more vigilant at full speed, when the machinery requires, in addition to the automatic lubrication, the greatest care on the part of the attendants.

Another source of waste is the use of fluid lubricants on journals having but little motion; some of the various grease compounds will do just as well, and be far more economical. By the use of compression cups, ample lubrication can be provided for such journals as those connected with the valve gears, without resorting to the use of the squirt can. In addition to being more economical, the compound is much cleaner, as the small amount of it used can be easily wiped off.

Thrust bearings, if not properly arranged, require a large amount of oil. They should be so arranged as to run in oil and be provided with oil tight covers to prevent the oil from being thrown out by the centrifugal force. By circulating sea water through a coil in the lower part of the thrust no difficulty need be experienced in keeping the oil at a sufficiently low temperature. If the stuffing boxes at the ends are kept tight, the leakage can be reduced to a minimum.

Eccentrics, as a general thing, require a considerable amount of oil, but if they are so arranged that the lower parts of the straps dip into fresh water in the drip pans, they will be found to run cool on a greatly reduced amount of oil, as compared with those which are not kept cool by water.

The practice of automatically oiling piston rods and valve stems is a poor one, inasmuch as the lighter oils, such as are used in overhead reservoirs for the other running parts, are almost worthless on hot rods. An occasional swabbing with thick cylinder oil will, in most cases, suffice to prevent undue heating.

The recent naval practice of having one large tank as high up under the protective deck as possible, from which all reservoirs about the engine are filled, is very advantageous, not alone from the increased head obtained, but from preventing the frequent spilling which occurs while filling the reservoirs from large cans or feeders. A great saving in oil can be accomplished by the use of a good filter, wherein as much waste oil as can be caught, is, after filtering, ready to be used over again. The crank pits or drip pans should be provided each with a drain pipe leading into a small tank placed below the level of the bottom of the pits. In this way at least one-half of the oil which would otherwise go to waste can be saved.

In general, the question of economy in the use of lubricants, resolves itself into a personal equation, to a large extent. Where one oiler, by vigilance and good judgment, can keep an engine running cool, with a certain allowance of oil, another may use twice as much with no better results; however, with the adoption of economical methods, and a strict supervision of the engine room force by the engineer on watch, it is safe to say that there are but few ships where a saving could not be accomplished.

In regard to the materials used, much satisfactory advance has been made, of late, in their lubricating qualities. The present tendency seems to be to use as little of animal oils as possible. This, no doubt, is largely due to the gradual cheapening and improvement of the light mineral oils. Another excellent reason for the abolition of animal oils, especially of lard oil, is the bad stench which it creates in the engine room bilges. Animal oils are also very liable to clog up the distributing pipes, unless they are frequently cleaned out.

The lubrication of the internal surfaces of steam cylinders is a very important subject, especially on vessels that are equipped with water tube boilers. The practice on torpedo boats is to use no lubricants at all in the cylinders of the main engines. The question naturally arises, if these fast running engines can do without cylinder oil, why cannot the larger and slower running engines? If shipbuilders would have the courage to run the engines on trial without oil in the cylinders there would be no necessity of using oil thereafter. I know of several instances where large triple expansion engines have never had any oil in the cylinders, and from the appearance of the bores, have not suffered thereby. What is true of the main cylinders should apply to the cylinders of the auxiliary engines, but it frequently happens that many of them will not work well without the use of cylinder oil. This is especially so in the case of dynamo engines, which seem to require an abnormal amount of oil. It frequently happens that even on ships where no oil is used in the main engines, an examination of the boilers will show that undue amounts of oil have entered in the feed water, which can only be traced to the dynamo engine. Much of this is due to the use of the automatic sight-feed lubricators, which are in such common use. No matter how carefully the flow of oil may be regulated in such a contrivance, they are bound to inject far too much oil into the engine. If cylinder oil must be used, it should be mixed with plumbago and put in by a hand pump, and then at only such times as it is absolutely necessary.

BEESON'S MARINE DIRECTORY.—In enlarged form and with the contents brought down to date Beeson's Marine Directory of the Northwestern Lakes for 1900 has been issued. This is the thirteenth annual edition. Among the chief features of the work are: Lists of American steam and sailing vessels on the Lakes; lumber carriers, with capacity; record of vessels lost in 1899; record of engines and boilers of lake vessels; names and addresses of vessel owners of the Great Lakes; concise report on each of the lake ports, classified directory of firms and corporations connected with marine interests on the lakes. In addition there is a great variety of other intelligence, most of it of special value for purposes of reference. There is also a number of interesting views of lake vessels and other craft contained in the volume. It is printed on good stout paper (255 pages, 6 1-2 in. by 9 1-2 in.) and is strongly bound in cloth boards, so that it will stand considerable handling without injury. The directory is published by Harvey C. Beeson, 308 Royal Exchange Building, Chicago, Ill., and is sold for $5.00 a copy.

It is understood that the U. S. government will purchase the Spanish floating dry dock at Havana.

THE NAVAL STEAM ENGINE--ITS GRAPHICS AND ECONOMICS ILLUSTRATED--III.

BY ROBERT H. THURSTON.

As already indicated, the internal wastes, which are the most serious of all the avoidable forms of loss in the simple engine of Watt and his contemporaries, may be reduced by steam jacketing, as first practiced by that great inventor—the first to recognize their real nature—in the attempt to extinguish this form of waste, by superheating, or by compounding. In the modern engine of highest efficiency, as a rule, both compounding and jacketing are adopted, and the result is the reduction of the internal wastes very considerably. In the next diagram, Fig. 5, the method of gain by this system of multiple expansion, by placing cylinders in series, in such manner that the wastes of the smaller shall be utilized in meeting the demand for steam to supply wastes in the larger cylinders, is practically to divide this internal loss by the number of cylinders thus arranged in series. When the waste of anyone cylinder, thus added, becomes so far minimized that its addition no longer pays, either through exaggerated external and friction wastes, or because of its cost, the process of economizing ceases.

In the diagram, Fig. 5, let the costs of power, in the ideal cycle here taken as the relative standard, be represented by the lowest curve of the set, its measure being given in *B. T. U.*, on the left, and in pounds of steam per horse power per hour, on the right. The data assumed are initial pressure 125 lb. back-pressure 1.5 lb., ratios of expansion ranging from unity to thirty, condensation complete and feed-water taken from the hot-well at the condenser temperature.

Under such conditions of operation, the purely thermodynamic machine would thus demand from 40,000 to 50,000 *B. T. U.* at full stroke, down to 10,000 at fifteen and about 7,500 at thirty. Adding the friction wastes of the real engine, as found by trial of the better class of such machines, we obtain the second curve of the set, giving costs of power several per cent higher. Then adding the internal wastes and neglecting external losses as unimportant, we obtain, for the simple engine, the curve next the upper, bounding, curve of the series, as the measure of the demand for heat and steam of a simple engine of moderately large size, operated under what would be regarded as ordinarily favorable conditions, and considerably better than in the average case of engines in general use. The costs of power are here from above 45,000 *B. T. U.* at full stroke, to 20,000 as a minimum; the latter, as here found, at about a ratio of expansion of 12. At thirty expansions, the figure rises nearly to the cost of full stroke. Adding, still further, the equivalent of the operating expenses, apart from those of supplying steam, and we obtain the upper line of the diagram, showing that the total costs of power-supply become a minimum at some ratio of expansion, at some cut-off, sensibly different from that described by a comparison of "duties" and of steam and fuel and heat expenditures. This final criterion always dictates a moderate ratio of expansion and often makes the best cut-off considerably less than does the duty requirement simply. Here it reduces the ratio of expansion to about nine, instead of twelve or thirteen.

Compounding the engine, by the addition, by McNaught's system, we will say, of a high-pressure cylinder, the internal wastes are reduced by about one-half and the middle curve of the series is produced, showing a demand for heat and for steam, as a minimum, one-third less than with the simple engine and increasing the allowable ratio of expansion to sixteen. Similarly the conversion of the system into a triple-expansion arrangement, dividing the internal wastes by about three, gives makes the cost of power, measured in thermal units and in weight of steam demanded, about sixty per cent. of the figures for the simple engine, making them about 12,000 *B. T. U.* and 12 lb. of steam, as against 20,000 *B. T. U.* and 20 lb. Finally, making the machine quadruple-expansion, the figures drop to one-half their maximum, to 10,000 *B. T. U.* and 10 lb. of steam, approximately, and the available expansion becomes twenty-four for this particular case, as based upon the thermodynamic case and non-financial considerations. Taking into account the operating costs, as a whole, and constructing a new line, as in the case of the simple engine, this would make the allowable ratio of expansion more nearly fifteen or eighteen, for the triple and quadruple engines, and perhaps about twelve for the compound engine.

NAVAL ENGINES, as already remarked, are subject to quite different conditions, in design, as in operation, from the engines of mills and factories, or even from those of the mercantile marine. They will, and should, therefore, give a somewhat different distribution of the energies supplied them from their boilers and utilized, in greater or less degree, in application to the propulsion of the ship.

The following represents the method and the outcome of an attempt to ascertain what is this distribution, in the general manner previously described, in the case of a famous and successful iron-clad, of which the contract-trial figures are available. The method is that which has been employed by the writer, and his fellow investigators in office-work, for a long time, and is simply the method of Rankine, so far as it affects the ideal case, supplemented by the processes of discussion of the distinctive features of real engines, in the forms assumed by them during the years of gradual development of the complete theory of the real steam-engine and of other real heat engines, since the days of Clark's, of Hirn's, and of Isherwood's pioneer work.

The computers, in the present case, were Messrs. Austin and Howell, of Sibley College, who became sufficiently interested in this subject, and in the development of naval engineering, to undertake the investigation, submitting the final report as a part of their advanced work in this field of higher engineering.

In choosing a subject for this investigation, it seemed preferable to take an actual case, a test known to be reliable, and to work out the corresponding ideal cases, computing the various wastes by formulæ derived, as has been indicated, from previous experimentation.

The test chosen was the contract trial of the U. S. S. *Maine*, in October, 1894.[4] The data are complete, ex-

[4] The engines of the *Maine* are fully described in the *Journal of the American Society of Naval Engineers*, 1895.

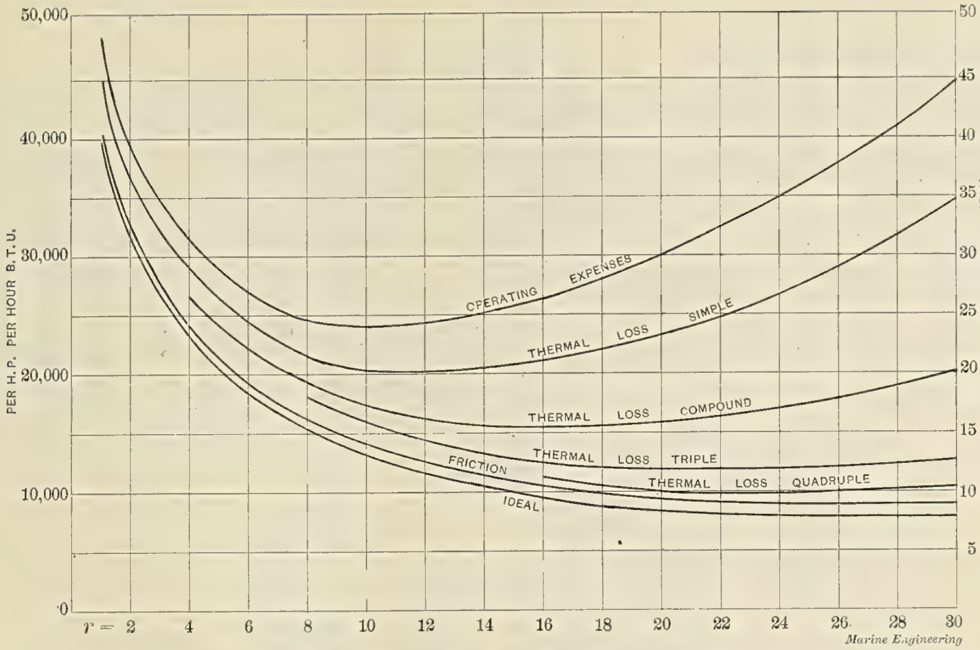
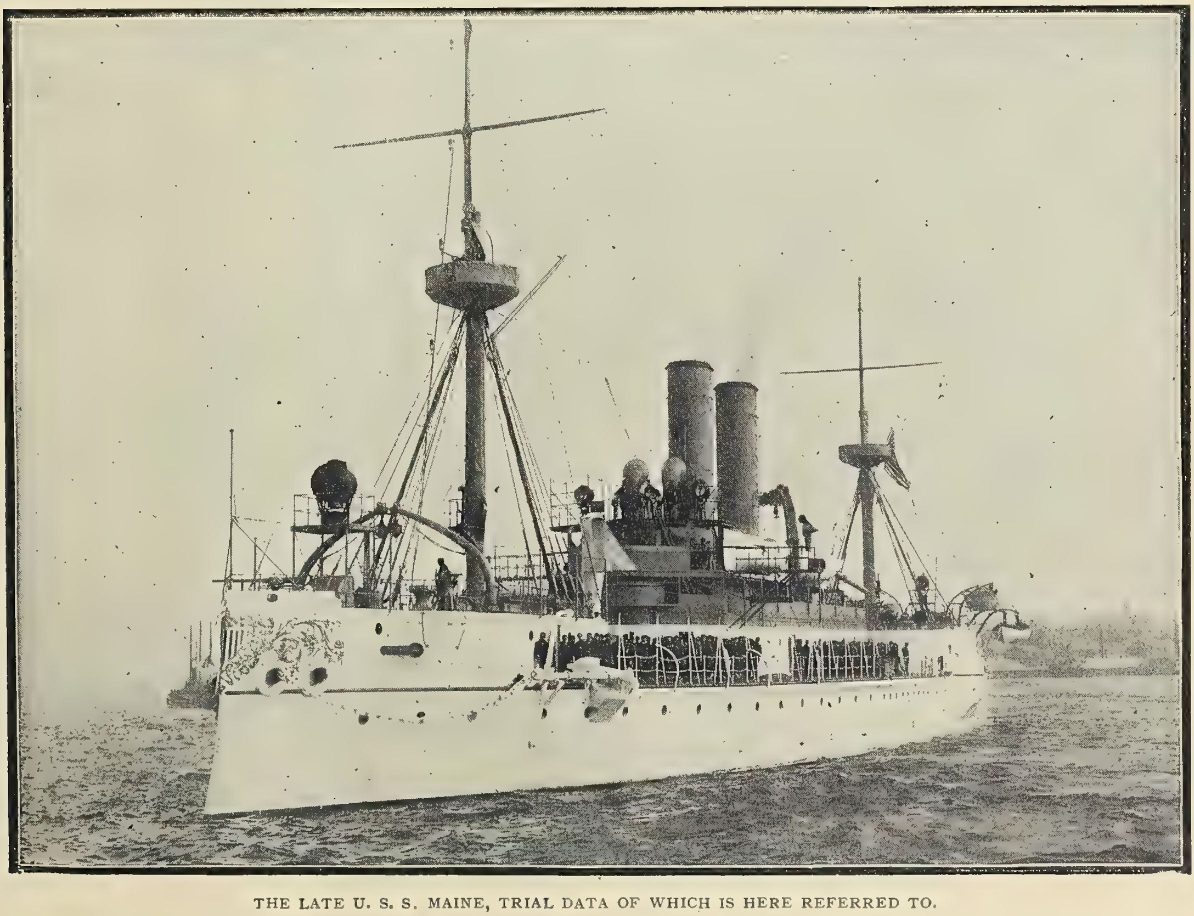
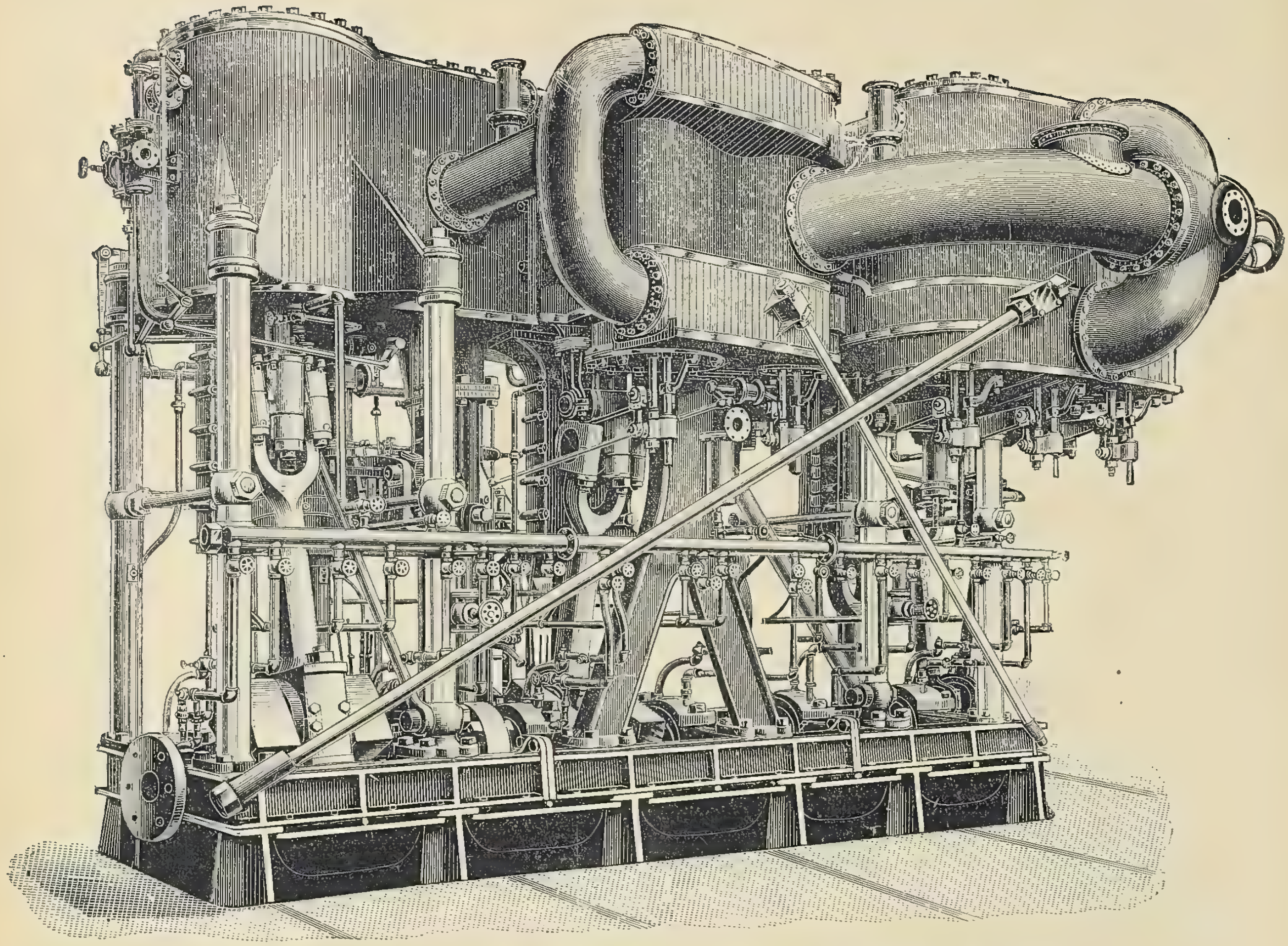


FIG. 5—EFFICIENCIES OF ENGINES (JACKETED).
$P_1 = 125$; $P_3 = 1.5$; 1,500 *H. P.*

cept in one particular: no measurement of the steam used during the test was made. To supply this deficiency it was necessary to assume an evaporation-rate. Pocahontas coal was used with forced draught, 35.3 lb. being burned per sq. ft. of grate surface per hour, and for the type of boiler in use on this vessel, with this rate of burning, an evaporation of 9 lb. of water per lb. of coal is taken to represent an excellent perform-



THE LATE U. S. S. MAINE, TRIAL DATA OF WHICH IS HERE REFERRED TO.



THREE CYLINDER THREE CRANK TRIPLE EXPANSION ENGINES OF THE LATE U. S. S. MAINE.

ance. It is probable that any error lies on the side of excess of computed over actual steam consumption.

THE PRINCIPAL DIMENSIONS and proportions of the machinery are:

TABLE III.—DIMENSIONS.

Number of cylinders (each engine)	3
Dia. of H.P. cylinder, in	35½
I.P. cylinder, in	57
L.P. cylinder, in	88
Stroke of all pistons, inches	36
Dia. of H.P. valves (one for each cyl.), in	22
I.P. valves (two for each cyl.), in	22
L.P. valves (three for each cyl.), in	22
Area H.P. steam port for max. opening, top, sq. in	104.260
bottom, sq. in.	132.352
I.P. steam port for max. opening, top, sq. in	134.576
bottom, sq. in.	260.640
L.P. steam port for max. opening, top, sq. in	449,604
bottom, sq. in.	508.248
H.P. exhaust port for max. opening, top, sq. in	203.
bottom, sq. in.	203.
I.P. exhaust port for max. opening, top, sq. in	406.
bottom, sq. in.	406.
L.P. exhaust port for max. opening, top, sq. in	609.
bottom, sq. in.	547.14
main steam pipe (12 in. dia.), sq. in	113.1
H.P. steam pipe (13 in. dia.), sq. in	132.7
I.P. steam pipe (20 in. dia.), sq. in	314.2
I.P. exhaust pipe, to condenser (16 in. dia.), sq. in.	201.06
L.P. exhaust pipe (28 in. dia.), sq. in	615.75
Volume swept by H.P. piston per stroke, mean cu. ft.	20.30
Volume swept by I.P. piston per stroke, mean, cu. ft.	52.84
L.P. piston per stroke, mean, cu. ft.	126.39
Clearance, in cu. ft., H.P. cyl., top	4.974
bottom	4.744
I.P. cyl., top	10.161
bottom	9.094
L.P. cyl., top	22.376
bottom	17.344
Clearance, per cent., H.P. cyl., top	24.12
bottom	23.74
I.P. cyl., top	19.113
bottom	17.314
L.P. cyl., top	17.65
bottom	13.76
Ratio of net area of H.P. to I.P. pistons	1 to 2.578
I.P. to L.P. pistons	1 to 2.383
H.P. to L.P. pistons	1 to 6.144
Dia. of piston rods, in	6¼
Length of connecting rods between centers, in	73¾
Dia. of connecting rods, in	6½ and 10

OFFICIAL TRIAL.[5]

The official trial for horse power took place on the 17th of October, 1894, in Long Island Sound. The *Maine* left her anchorage off New London Light at 12 meridian, and proceeded out through the Race, and when off Watch Hill was turned and headed to the westward in order to make as nearly as practicable a straightaway run for the four consecutive hours' trial required by the contract.

The trial began at 1.30 P. M., and ended at 5.30. The weather conditions were not very favorable, for throughout the entire run the ship was steaming against a strong head wind and sea, which increased in force to the end of the trial. The ship was remarkably steady, and at the maximum speed of the engines very little vibration was noticeable.

The speed was very accurately obtained for a portion of the trial, while running over the official measured

[5] From the official report.

course laid down for the trial of the *Ericsson.* The average speed for this 25-mile course was 15.95 knots, and with a mean allowance of 1,5 knots for the strong head wind and tide, the average speed of the ship was 17.45 knots.

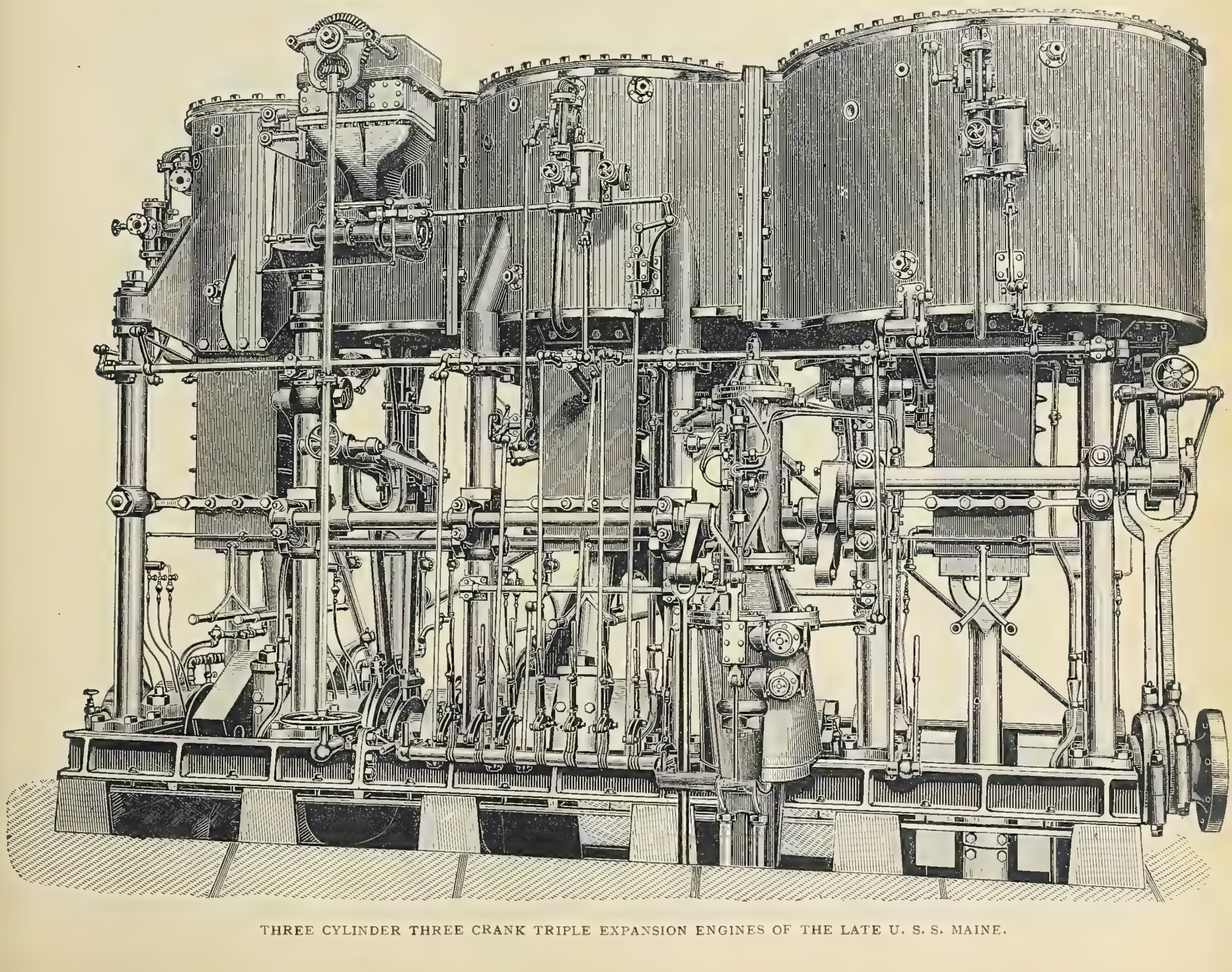
TABLE IV.

DATA OF OFFICIAL TRIAL, U. S. S. "MAINE."

Draught of water at beginning, forward, ft. and in.	18— 2
aft., ft. and in.	19— 1
at end, forward, ft. and in.	17—10
aft, ft. and in.	18—11
mean, for trial, forward, ft. and in.	18— 0
aft., ft. and in.	19— 0
Disp. at mean draught on trial, tons	5,500
Area of mid. section at 18 ft. 6 in. mean draught, sq. ft.	906
Wetted surface, sq. ft.	21,850
I.H.P. (total) per 100 sq. ft. of wetted surface	42.53
I.H.P. per 100 sq. ft. of wetted surface at 10 knots in ratio of 3.5 power	6.0142
Mean speed, knots	17.45
Slip of screws, mean, per cent, starboard	12.805
port	10.205
Speed^3 $\times$ area immersed midship section $\div$ I.H.P.	518.26
Speed^3 $\times$ displacement$^{\frac{2}{3}}$ $\div$ I.H.P.	165.21

Synopsis of Steam Log.	*Starboard.*		*Port.*
Revolutions of main engines per min., mean	125.96		122.313
Piston speed, ft. per min	755.76		733.878
Steam at boilers, gauge		144.9	
engines, gauge	136.27		134.63
first receiver, absolute	67.70		66.33
second receiver, absolute	28.84		34.34
Vacuum in condenser, in. of mercury	23.875		22.839
Opening of throttle, tenths		10.	
Steam cut off in fraction of stroke from beginning, H.P.	.8		.8
Steam cut off in fraction of stroke from beginning, I.P.	.7		.7
L.P.	.7		.7
Double strokes of combined air and circulating pumps	51.55		42.444

	Starboard.		*Port.*
Temp. in deg. Fahr., steam at H.P. cyl.	364.0		363.4
Temp. in deg. Fahr., injection		63.	
discharge	114.		99.5
hot well	127.3		127.3
feed	127.3		127.3
engine rooms, upper		146.	
lower		99.	
fire rooms, forward		127.	
after		134.	
Revolutions of blower per min., main boilers		450.	
Air pressure in in. of water, ash pits		1.074	
furnaces		.92	
H.P. cyl., mean pressure	54.372		53.656
I.H.P.	1,216.89		1,165.56
I.P. cyl., mean pressure	20.907		19.597
I.H.P.	1,218.35		1,108.94
L.P. cyl., mean pressure	16.236		16.267
I.H.P.	2,261.75		2,200.00
Aggregate equivalent mean pressure on L.P. piston	33.7175		33.0855
I.H.P. collective of each main engine	4,696.95		4,474.50
of both main engines		9,171.45	
of combined air and circulating pumps	28.25		24.593
collective of air and circulating pumps (2)		52.843	
of all forced draft-blowers (4)		38.068	
of main feed pumps (2)		15.429	
of other auxiliaries		14.856	
of all auxiliaries		121.1962	
each main engine, air and circulating pump	4,725.20		4,499.093
both main engines, air and circulating pumps		9,224.293	



THREE CYLINDER THREE CRANK TRIPLE EXPANSION ENGINES OF THE LATE U. S. S. MAINE.

I. H. P. total of all machinery in use....	9,292.646	
Indicated thrust (I.H.P. main engines).	57,354.40	
per sq. in. of surface of thrust bearings..	59.31	
Cu. ft. swept per min. by L.P. piston, per I.H.P. of main engines..........	6.73	6.87
Sq. ft. of H.S. per I.H.P.................	2.0462	
of cooling surface per I.H.P......	1.5087	
I.H.P. of all machinery in operation, per sq. ft. of G.S..................	16.1938	
I.H.P. per ton of propelling machinery, boilers and water	14.18	
Coal Consumption.		
Sq. ft. of G.S. in use..................................	573.84	
H.S. in use	19,015.36	
Kind and quality of coal used.........	Pocahontas, good quality.	
Coal burned per hour, actual weight, lbs............	20,272.	
per sq. ft. of G.S., lbs.......	35.327	
H.S., lbs.......	1.066	
per I.H.P. of all machinery, lbs.	2.1815	
per I.H.P. of main engines, air and circulating pumps, and feed pumps, lbs.	2.194	

(To be continued.)

German Torpedo Boats.

There was recently launched at the Schichau shipyard at Elbing, the one hundredth torpedo boat constructed for the German Navy. The launching was a ceremonious occasion, and it was the subject of much comment in the German press. As showing the German view of such matters, we here publish a translation of an article on the event from one of the leading German journals, as follows:

> Torpedo boats are divided into two classes—pole torpedo boats and fish torpedo boats. The first-named variety first demonstrated their utility in the American war of the rebellion. In those days the boats were very small and were called "Davids" after the Jewish king. The boat had a pole 30 ft. long attached to the bow, and a torpedo was placed at the forward end of this and was exploded by contact with the enemy's vessel. During the above mentioned war the most notable event in the use of this type of boat was the attack which was made by Lieut. Cushing on the Confederate armored vessel *Albemarle*, Oct. 27, 1864, at three o'clock in the morning in the Roanoke River. The explosion of the torpedo tore a large hole in the *Albemarle* close to the water line, and she sank in a few minutes, but the torpedo boat was swamped by the column of water which was thrown up by the explosion.
>
> In the Turko-Russian war of 1877-78 two Turkish monitors were destroyed on the Danube River by a night attack of Russian pole torpedo boats.
>
> The first large torpedo boats were the armored American boat *Spuyten Duyvel*, built in 1865, and the English boat *Vesuvius*, both with a speed of 10 knots, and the German boat *Ulan*, all fitted with pole torpedoes. At the time of the Franco-Prussian war the German Navy had a number of pole torpedo boats, which had a speed of only 8 knots and which were not brought into play at all. The first practical boats of both types were built at the English yard of Thornycrofts. In Germany the Schichau yard at Elbing had already built quite a number of boats for the Russian Navy since 1877, when the German Admiralty made a comparative test of the boats of all the well known builders. The superiority of the Schichau type as developed by their constructor, Mr. Tiese, was so pronounced that even in the British Navy it was given precedence under the name of "German type." These torpedo boats were mostly 115 to 150 ft. long, with a draft of about 6 1-2 ft., and a displacement of 85 to 144 tons, and were built of steel, combining strength and lightness. The crew of one of the 90-ton torpedo boats consisted usually of one naval officer as commander, one chief engineer, two junior officers, three assistant engineers, four sailors and four firemen.
>
> The adopted system in Germany at present consists of a rather large type of boats, very seaworthy and having a large radius of action and all built with a certain uniformity to each other. Other navies have, in addition to this class, a large number of smaller boats, with small radius of action, and which can only be used at local points for coast defense. In 1897 a torpedo boat called the *Turbinia* was tested in England. This boat was fitted with Parson's turbines instead of the usual reciprocating engines. It was believed at that time that Thornycroft had put Schichau out of the field with this boat, but this has not materialized.
>
> If at times one or two trial boats were occasionally ordered elsewhere, the German Navy has always returned to Schichau. The German torpedo boat fleet stands as a model to the whole world, and this is amply demonstrated by the numerous orders received by Schichau from foreign nations. Up to the present time the Schichau yards have turned out 265 torpedo boats, of which 100 were for the German Navy. Altogether 674 vessels were launched at this yard.
>
> The new torpedo boat S100 belongs to the new series S90 to S101, of which the first boat has made all its trial trips very successfully and has proven itself seaworthy. The principal dimensions are as follows: Length, 200 ft.; beam, 23 1-2 ft.; draft, 8 1-2 ft.: displacement, fully equipped, 350 tons. The average speed is 26 knots in a long run. The twin triple expansion engines develop 6,000 I. H. P. The shop number of the engines is 1878-79, and of the boilers 2168-70. These may be simple figures, but to the initiated they represent an enormous amount of work, experience and success in ship and engine building, which no other concern in the world can approach.
>
> We wish the jubilee torpedo boat S100 all the success and hope that it may bring honors to its builders and satisfaction to the greatest of War Lords, His Majesty, the German Emperor.

It will be noticed that, contrary to the usual European attitude, proper credit is given to the United States for the origin and early development of the torpedo boat, which, though crude when compared with present practice, was effective in its way, and like our monitor, was the cause of many subsequent radical changes in naval construction the world over. The little sketch of torpedo work written by our German contemporary is very fragmentary and does not cover all the exploits of the torpedo. We have not attempted to embellish it, but to present it to our readers as originally written. The author, however, is not up-to-date on the developments in turbine driven torpedo vessels, as the *Turbina* is now a back number when compared with the *Viper* and *Cobra*, which have been reeling off about 35 knots lately on trial. It is interesting, also, to note that there is nothing small about the claims of our contemporary as to the superiority of the German boats. We believe the United States have been often criticized abroad for the frequent use of superlatives, but apparently we have not a monopoly in this special field of mental activity. The reference to Emperor William represents also an interesting national view which would not, perhaps, find unqualified endorsement on other than German soil.

LAUNCHES—HOME AND FOREIGN.

S. S. LAFAYETTE.—The S. S. *Lafayette*, for the Pittsburg Steamship Co., was launched at the Lorain, Ohio, shipyard, May 31. Instead of the usual bottle of wine being broken upon the christening of the vessel, the Japanese custom of releasing a basket of doves was adopted, this ceremony being performed by Miss Harriet Lauder, daughter of George Lauder, managing director of the Carnegie Steel Co. The vessel is a sister ship to the others for the same company named after well-known institutions of learning, the *Princeton, Cornell, Harvard* and *Renssalaer*. The vessel is of these dimensions: Length over all, 474 ft.; beam, 50 ft.; depth, 28 1-2 ft. She is designed to carry 7,200 gross tons of ore on 18 ft. draft. Her engines, of nearly 2,000 horse power, are of the quadruple expansion type of these dimensions: 18 in., 26.34 in., 41 in., and 63 in. dia., and 42 in. stroke. Steam will be generated in water-tube boilers of the Babcock & Wilcox type.

S. S. JAMES S. WHITNEY.—The steel single screw freight steamship *James S. Whitney*, for the Metropolitan Steamship Co., of New York, was launched June 4, at the Harlan & Hollingsworth yard at Wilmington, Del. The vessel was christened by Miss Ruth Whitney, daughter of the president of the line. The vessel is of these dimensions: Length over all, 288 ft. 9 in.; beam, 43 ft.; depth to awning deck, 29 ft. She is fitted with six water tight bulkheads, four hatches and eight side ports. The engines are of the triple expansion type with cylinders 29 in., 46 in. and 75 in. dia., and 46 in. stroke. Steam is supplied by four return tube boilers 13 ft. long by 14 ft. dia., built for a working pressure of 175 lb. The deck houses are of lumber, with accommodations for twenty-one sailors and firemen and twenty-three officers and passengers.

S. S. ALFRED MITCHELL.—The wooden freight steamer *Alfred Mitchell*, 2,800 tons, was launched from the yard of Simon Langill at St. Clair, Mich., last month.

S. S. MONTREAL.—There was recently launched from the yard of Swan & Hunter, on the east coast of England, a large twin screw vessel for the Atlantic trade of Elder, Dempster & Co. The vessel is named the *Montreal*, and is of these dimensions: Length, 470 ft.; beam, 56 ft.; depth, 42 ft. 9 in. She is built to conform to Lloyds' highest 3-deck class. Special provision is made for carrying beef on the hoof, the vessel having room for 750 head. The machinery will consist of twin triple expansion engines, with cylinders 22 in., 37 in., and 61 in. dia., by 48 in. stroke. The deadweight capacity of the new vessel is about 10,600 tons, and she will have a sea speed of about 12 knots.

FERRYBOAT JOHN ENGLIS.—The steel hull of the ferryboat *John Englis*, for service in the East River, New York, was launched at the Marvel shipyard at Newburg, N. Y., on Saturday, June 16. The vessel is of these dimensions: Length over all, 193 ft.; beam molded, 37 ft.; beam over guards, 62 ft. 6 in.; depth molded, 14 ft. 9 in. She will be fitted with her machinery at the yard of the W. & A. Fletcher Co., Hoboken, N. J. The engine will be of the beam type with single cylinder 50 in. dia. and 10 ft. stroke, built for a working pressure of 55 lb. of steam. The wheels will be of the radial type, 21 ft. 3 in. dia., with buckets 8 ft. 6 in. long.

LAUNCH OF THE ONE HUNDREDTH TORPEDO BOAT BUILT BY HERR SCHICHAU FOR GERMAN NAVY.—See Page 300.

S. S. A. B. WOLVIN.—At the Globe Yard, Cleveland, Ohio, June 9, the S. S. *A. B. Wolvin* was launched. Mrs. H. G. Dalton performed the ceremony of christening the vessel. The vessel is of the full Welland Canal size, of these dimensions: Length, 256 ft.; beam, 42 ft.; depth molded, 26 ft. On a Welland Canal draft of 14 ft. the vessel will carry 2,100 tons, and on an 18 ft. draft she will carry 3,600 tons. The machinery will be of the quadruple expansion type, with engines of 1,200 I. H. P. and Babcock & Wilcox boilers.

S. Y. WATURUS.—At Leith, Scotland, the steam yacht *Waturus*, for the Archduke Stefan, of Austria, was launched recently. This pleasure vessel, which will

be very luxuriously fitted up, is of these dimensions: Length over all, 217 ft.; beam molded, 27 ft. 6 in.; depth molded to main deck, 16 ft. 2 in. She will have a single screw driven by triple expansion engines with cylinders 18 in., 28 in. and 49 in. dia., and 33 in. stroke, taking steam at 180 lb. pressure. She is built to conform to Lloyds' rules.

S. S. Ontarian.—A new cattle carrying steamer for the Allan line in the Atlantic trade was launched in May at Port Glasgow, Scotland. This vessel was built under the rules of the British Corporation and was christened the *Ontarian*. Her dimensions are: Length, 385 ft.; beam, 48 ft. 6 in.; depth, 29 ft. 6 in., and deadweight capacity about 7,000 tons. Her engines have cylinders 27 in., 43 in., and 72 in., by 48 in.

S. S. Sierra.—The first of the three steamships ordered by the Oceanic Steamship Co. was launched at Cramp's shipyard, May 29. This vessel is named the *Sierra*, and will be put into service on the Pacific on the Oceanic Company's route between San Francisco and Australia, touching at Hawaii. The S. S. *Sierra* is of these dimensions: Length, 400 ft.; beam, 50 ft.; depth, 36 ft.; displacement, 7,000 tons.

S. S. Ottawa.—At the Bertram Shipyard, in Toronto, Ont., the S. S. *Ottawa* was launched, May 23. This vessel is of Welland Canal size, package freighter, of the following dimensions: Length, 257 ft.; beam, 43 ft.; depth, 25.6 ft. She will carry 7,000 bushels of wheat on a canal draft of 14 ft., and in deep water she will carry about 100,000 bushels.

Tow Barge Bryn Mawr.—At the South Chicago Shipyard, South Chicago, Ill., the steel tow barge *Bryn Mawr*, for the Pittsburg Steamship Co., was launched June 12. She is of these dimensions: Length over all, 414 ft.; beam, 50 ft.; depth, 27 ft. She will carry 5,900 gross tons of ore on a draft of 18 ft.

Barge Indiana.—The four masted barge *Indiana* for the Coastwise Steamship Co., of New York, was launched at the New England yard, Bath, Me., June 2. Her dimensions are: Length, 237 ft.; beam, 43 ft.; depth, 20.5 ft.; capacity, 3,000 tons.

S. S. Harvard.—The lake S. S. *Harvard*, for the Pittsburg Steamship Co. (Carnegie Steel interests) was launched into the Detroit River at the Wyandotte yard on May 21. The *Harvard* is 476 ft. long over all, with a capacity of 8,000 gross tons.

S. Y. Kittewan.—At Weller Bros. yard, Trenton, N. J., the S. Y. *Kittewan*, for S. P. Wetherill, of Philadelphia, was launched last month. The yacht is a wooden vessel measuring 108 ft. over all, 16 ft. beam and 9 ft. hull.

Lengthening S. S. Indian.—Cutting a steamship in two and putting in new work to increase her length has become a familiar job now in practical marine construction. A very successful example of this was carried out lately at the Harlan & Hollingsworth yard, Wilmington, Del., when the S. S. *Indian* was cut and the ends pulled apart a distance of 40 ft. for the purpose of increasing her length by that much. After all the rivets had been cut at the forward end, which was carried on special cradles in dry dock, she was pulled out the required distance in about seventy-five minutes. The portion moved weighed about 350 tons.

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—II.*

BY PROF. A. H. SABIN.

There yet remains to be described one other important pigment—red lead. This is entitled to be placed in a class by itself, because it is intermediate between the paints which it resembles in being used mixed with oil, and the cements, which it resembles in its process of solidification. It is, in fact, a powerfully basic substance, and combines chemically with the oil, forming an insoluble, hard, tenacious mass, in which the uncombined particles of the excess of lead oxide are imprisoned. This is what constitutes the protective film when a red lead paint is dry. Red lead is said by chemists to be a mixture of the peroxide and the protoxide of lead, the latter ingredient being the substance known as litharge. The peroxide is believed to be the characteristic ingredient. Red lead is made by a fire process in a suitably constructed furnace, and furnaces of different construction, or even of the same plan but of different dimensions, are said to give different products. At all events, it is well known that commercially pure red lead, composed of nothing but lead and oxygen, contains the peroxide in proportions ranging from 45 to 90 per cent. The correct proportions of peroxide and protoxide for making the best protective film are not known. Doubtless much of the uncertainty attaching to the use of red lead is due to this.

Linseed oil, made from flaxseed, is the liquid part of ordinary oil paints. It is sometimes obtained by treating the seed with naphtha, thus dissolving out the oil, which is separated by distilling off the solvent for use again. Comparatively little oil is made in this way, most of it being made by extraction under pressure. The seed is coarsely ground, is then heated, sometimes by running a jet of live steam into the meal, sometimes by putting the meal into a steam-heated vessel; it is then, by a machine, put into bags and pressed enough to make it take a suitable form, after which these bags are put into a powerful press and the oil is squeezed out. Moisture and other matters are of course mixed with the oil, and these are separated by allowing it to settle; it is at last filtered. This process of purification takes from one to three months, but even after this the oil improves for a long time by standing, during which some foreign matters separate and settle out.

Linseed oil possesses, in a higher degree than any other oil, the property of thickening rapidly on exposure to the air. This is not due to evaporation, but the contrary; it absorbs and combines with oxygen from the air, and thus actually increases in weight, though it decreases in bulk. A paint made with raw linseed oil alone will dry so that it may be handled in five or six days, but, as this is a long time, it is thought necessary to treat the oil so that it may dry more quickly; that is, may absorb oxygen more rapidly. Oil so treated is called "boiled oil." It used to be made by heating the oil over a direct fire in a kettle, and with this oil is mixed, by constant stirring, 1 to 3 per cent. of oxide of lead, either litharge or red lead, or both, and a small proportion of oxide of manganese. When the oil reaches

* From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies, U. S. A.

a temperature of about 500° F. it dissolves these metallic oxides, entering into chemical combination with them: and, as these have a great attraction for oxygen, the resulting oil, which is much darker in color than it was, has also greatly increased drying powers, and paint made with it will dry in twenty-four hours. The dark color is due partly to the combined metallic substances and partly to heating the oil for a long time.

It is believed that much more oil is present than can possibly combine with the small amount of metallic oxides, and that the product is therefore composed of a small portion of oil combined with the lead and manganese, dissolved in a large portion of oil, which is unchanged except that it has been darkened by heat. It has, therefore, become the custom of oil manufacturers to cook only a small portion of oil with the lead and manganese, and after these are dissolved they stir the product into a large quantity of raw oil at a heat about that of boiling water. The boiled oil thus made is much paler in color than that made in the old way, and is said to be quite as good in every respect. It probably is fully as good, and very likely better, being more nearly uniform. But oil made in this way varies according to the amount of oxides used, the proportionate parts of lead and manganese and the heat employed, so that boiled oil from different makers is always different; varying much more than raw oil does.

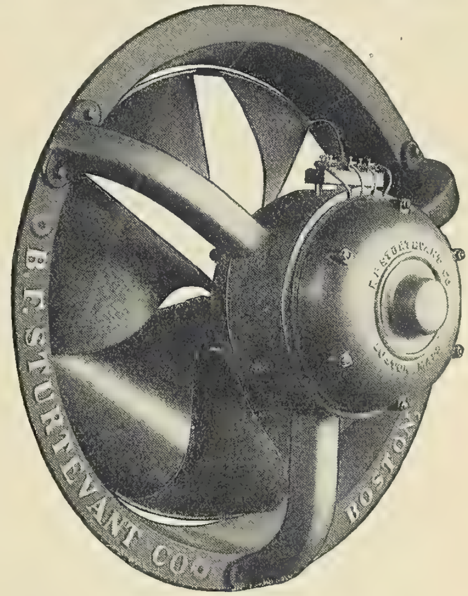
The foregoing method is the one used by the large manufacturers, but the smaller ones frequently, perhaps it may be said commonly, buy their oxides of lead and manganese already combined with just enough oil to make a compound; about four pounds of oxide of lead will combine with a gallon of oil, but the product in this case will be a solid cake. In order to liquefy this it is common to dissolve it in about two and a half gallons of turpentine or benzine (or a mixture of the two), and this solution, which is a good example of what is called a "drier," and which measures less than four gallons, contains enough metallic compound to go into about fifty gallons of oil—the contents of a barrel. So the small manufacturer or dealer opens a barrel of raw oil, takes out four or five gallons, fills it up with this drier, which he has purchased from some one who makes a specialty of it, closes the barrel, and, after rolling it about a little to mix it, sells it for boiled oil. Such oil is said to be boiled through the bunghole, and is spoken of disrespectfully by the large manufacturers; but those who follow this practice claim that such oil is in every way equal to that made in a kettle.

Commencement at Webb's Academy.—Commencement exercises were held last month at Webb's Academy and Home for Shipbuilders, at Fordham, New York City, at which Andrew H. Green delivered an address on the life work of the late William H. Webb, founder of the institution. In his address Mr. Green referred to the splendid products of the Webb yard in New York in the earlier days of steam navigation. Not only were steam vessels for coastwise and ocean trade put out, but war vessels, which in point of equipment and speed far excelled those of the time. Among such were the *General Admiral* for Russia, and the *Dunderberg*, originally constructed for the United States Navy, but afterward sold to France. A dozen members of the graduating class received the diploma of the Academy.

IMPROVED APPARATUS.

Electric Ventilating Fan.

The electric disc fan has become established as a local cooling device for summer use, but its ability is limited to merely stirring up a breeze. For the actual movement of air to or from buildings or through ducts a different type is required. The B. F. Sturtevant Co., of Boston, Mass., is now building a type of electric propeller ventilating fan such as is shown in the accompanying illustration which meets the latter requirements. The fan wheel is carefully designed to act against reasonable resistance and to move the air in lines parallel to the axis of the shaft. It is contained within a special circular frame casing which is conoidal in its form as it approaches the circumference of the wheel. This results in decreasing the resistance offered to the entering air. The frame carries a tripod support with annular centre within which is accurately placed and



ELECTRIC VENTILATING FAN.

centered a bi-polar motor, consisting of a circular field ring to which the pole pieces are attached. Extending out from either side of the field ring is a yoke which contains the ring oiler bearings. The bearings are self-aligning and self-oiling, and fitted with composition sleeves, which are removable from the outer end of the boxes. Special light end casings with removable centers are provided, which when applied and bolted in place entirely enclose the motor, thereby protecting it from dust.

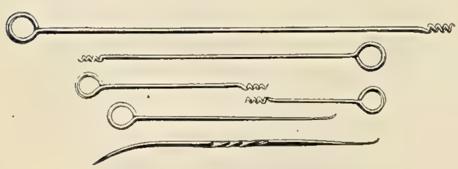
Set of Packing Tools.

A neat set of packing tools for engine room use is shown on page 304. They are made from tool steel, and are warranted not to bend or break when used in removing packing from stuffing boxes of main engines or auxiliaries. In cases of emergency, where work has to be done in a hurry, a set of these tools will be found to be a great convenience. They are manufactured by the Mound Tool & Scraper Co., St. Louis, Mo.

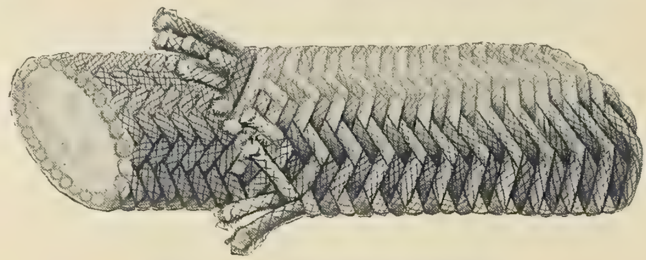
Semibronze Packing.

The engraving of semibronze packing which is presented herewith gives a good idea of the construction

and general appearance of this well known packing. As the name implies it is a combination packing combining advantages of both metallic and fibrous packings. The core, which is the foundation of the packing, is a lubricator reservoir, being composed of loosely spun asbestos thoroughly saturated with high grade cylinder oil and coated with pure foliated graphite. The covering over the core is composed of alternate strands of asbestos and flax all loosely spun and each braided over with an open net work of very fine semibronze wire. It is claimed the combination possesses the points that go



MOUND T. & S. CO. PACKING TOOLS.

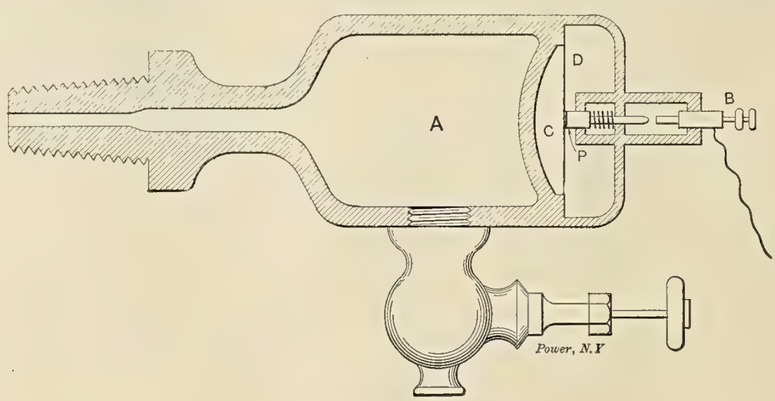


CHARLESTON SEMI-BRONZE PACKING.

to make a very durable packing for piston rods, as it is self-lubricating and has a metallic covering that protects the fibers of asbestos and flax from being blown out of the stuffing box by the steam or water pressure, and the net work of fine wire being quite open allows the lubricator to flow readily to the piston rod. Among the advantages claimed for semibronze packing are, that it will not scratch or groove the piston rods, that it requires no special care or attention in use, and that it is practically frictionless. Semibronze packing is now being used by many steamship and railway lines, by the U. S. Government in several branches of the service, and also by some of the largest mills and manufacturing concerns in the country. It is handled by the principal supply dealers, and is manufactured by the Charleston Metallic Packing Co., Charleston, S. C., which has a branch office at 32 Oliver street, Boston, Mass., to which address requests for samples should be sent.

Electric Alarm Try Cock.

A device for sounding a low water alarm has been brought out under the name of the Mathews electrical alarm try cock. A section view of this is here shown. The patent try cock is screwed into the water column or boiler in place of the lower gauge cock. Under normal conditions the water passes through the shank into the chamber *A* and fills this, thereby breaking the electric circuit. Should the water fall below the level of the cock the chamber would be filled with steam, which, by raising the temperature of the air in the chamber *C*, would cause it to expand and force out the *diaphragm D* against the plunger *P*. This in turn would come into contact with the binding post *B*, and by closing the electric circuit cause an alarm to be sounded at any distant point where it was located. If need be, more than one alarm can be operated simultaneously, say one in the fire room, one in the engine room, and one in the chief engineer's office. Where a group of boilers is in operation an annunciator is added, so that the particular boiler needing attention can be located. The circuit will remain closed until water again fills the chamber *A*, when the air in chamber *C* cooling down will allow the diaphragm to come back to its normal position. The spring on the plunger *P* will then act and break the contact with the binder post, thus opening the circuit. Suitable switches can be placed in circuit so that the alarm bell can be cut out after it starts ringing until such time as the contact is automatically broken again in the try cock. The try cock is supplied with bell, batteries, etc., ready for immediate connection. It is manufactured by the Electric Boiler Protection Co., 39 Cortlandt street, New York.

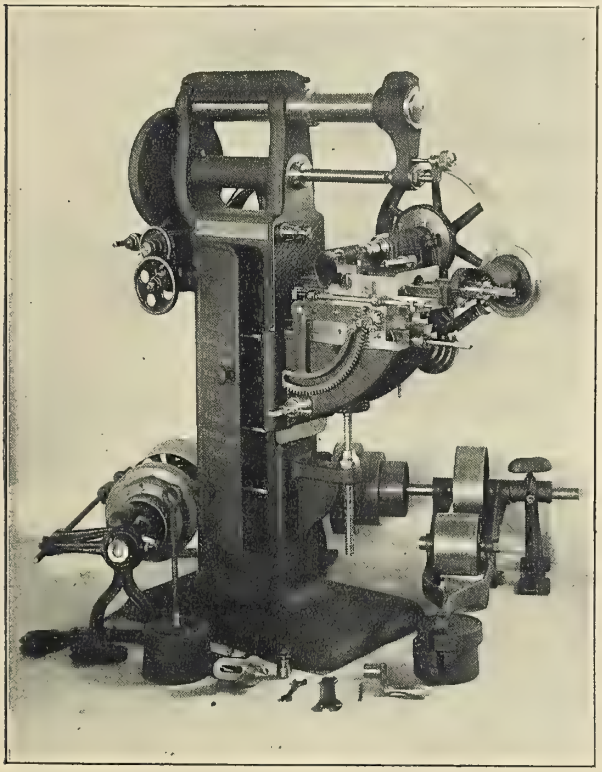


ELECTRIC ALARM TRY COCK.

Gear Cutting Machine.

In the engraving the Becker-Brainard 18 in. automatic gear cutting machine is shown, with countershafts. This machine is adapted for cutting spur, bevel, and worm wheels, and is automatic in all its movements. All the details are most carefully worked out. The dividing

wheel is finished with microscopic accuracy, and it is actuated by a steel worm with compensating devices for maintaining the original accuracy. It is protected by a close fitting shield, and the worm runs in an oil box. Among the features to facilitate accurate work are the centering device, which fixes the exact center of the cutter without reference to the position of the knee or other parts; the dial reading to thousandths of an inch, connected with the elevating screw and permitting the setting of the cutter to the correct depth without the use of separate depth gauges; also possible special adjustments of the cutter carriage for setting it at various angles. The automatic feed is arranged so that the feed cones and feed belt run always in one direction though feeding both ways as needed. The cutter spindle has a long taper center hole to receive the cutter, allowing a wide range of sizes to be used. It is also provided with an outer center support giving great steadiness in working. To admit of ready disconnection of the automatic devices, for examination of the work or operating the machine by hand, a radial clutch is placed on the feed screws. In the body of the machine the change gears are conveniently placed in a wooden case. With each machine an overhanging removable arm and a center with dog attached are supplied, and if desired a rack cutting attachment can be furnished. The maximum size of work which this machine will handle is: Diameter of cut, 18 in.; width of face, 4 in.; length of feed,

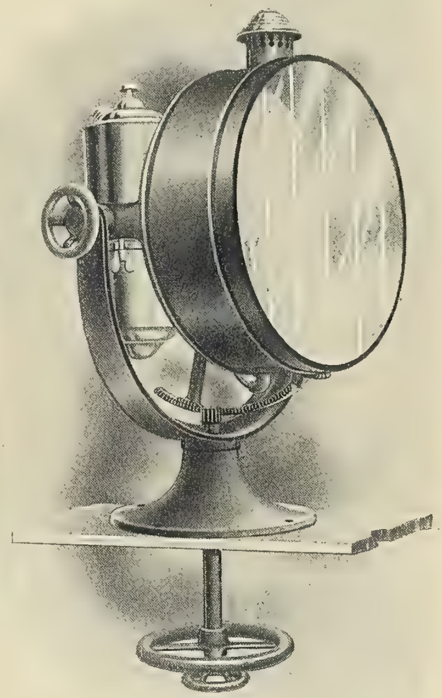


BECKER-BRAINARD GEAR CUTTER.

6 3-4 in. The machine is also made in larger sizes, 24 in. and 36 in. Additional details can be had from the manufacturers, the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Acetylene Search Light.

In boats which are not fitted with electric lighting equipment an acetylene search light is a very effective substitute for the electric projector. The light illus-



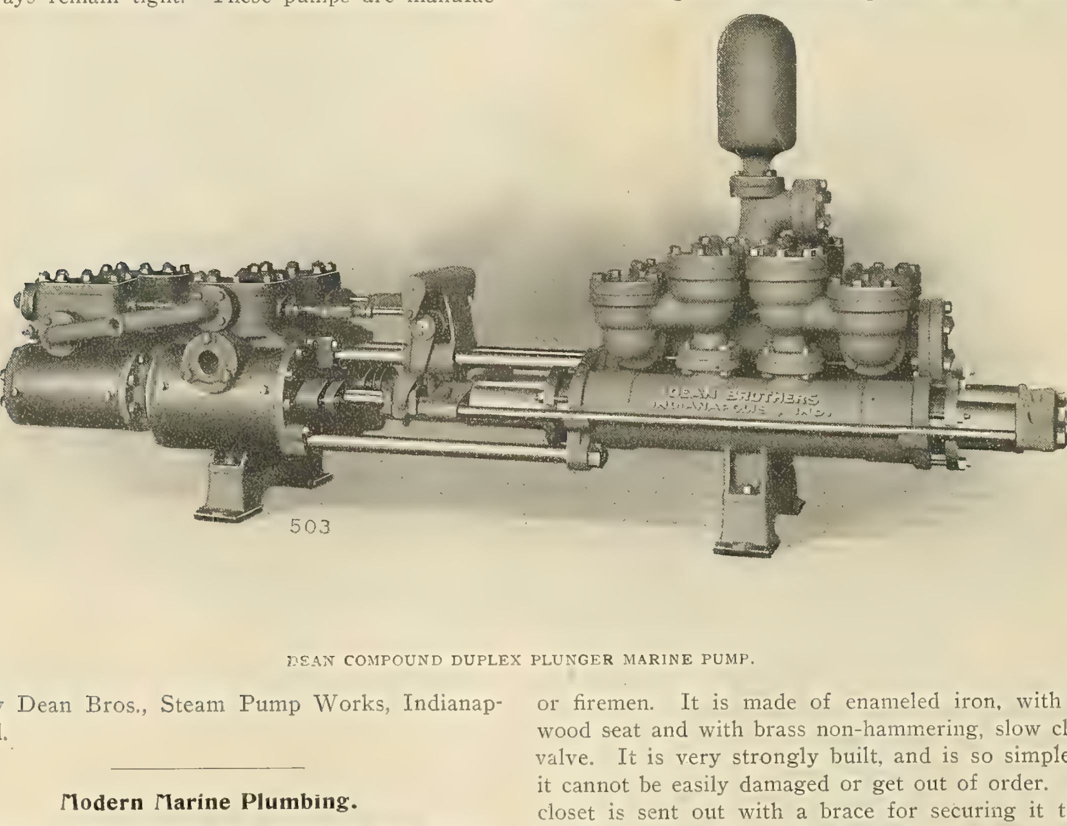
ACETYLENE SEARCH LIGHT.

trated has been specially designed for marine uses. It is self contained and requires no separate apparatus for generating the gas. The construction is very simple, the body of the searchlight being a bowl-shaped receptacle containing the reflector. The front of this receptacle consists of a glass cover suitably hinged so as to be opened for lighting the burner. To the back of the searchlight body the gas generator is directly attached. It is made ornamental in appearance and is nickel plated. All the trimmings of the searchlight are nickeled, while the stand and body are finished in black enamel. For manipulating the light from within the pilot house there is a segment of a gear attached to the body of the searchlight, and in this a small pinion engages. This pinion is connected with a small hand wheel within the house, and imparts a rocking motion to the searchlight. Horizontal motion is imparted by means of a larger hand wheel. When it is desired to direct the light from the deck the handling gear is dispensed with and the operator simply moves the searchlight itself in the required direction. This searchlight is manufactured by the Carlisle & Finch Co., 231 East Clinton avenue, Cincinnati, Ohio.

Compound Duplex Plunger Pump.

The pump here shown is especially designed for supplying marine boilers. It is very heavy, carefully made and constructed of the best materials. It is of the duplex type with tandem compound steam cylinders. The

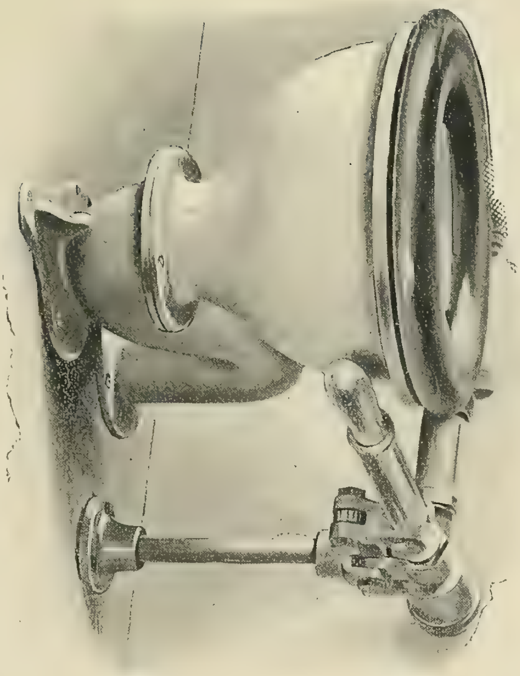
pump is of the double plunger "trombone" pattern, intended for working against high pressure for long periods without repairs. The plungers are of hard bronze and the stuffing boxes bronze lined. Plunger pumps especially under high pressure, have certain advantages over piston pumps. They are very durable, the only wearing part of the pump being the packing of the stuffing boxes. No leak can occur without its being seen, and it is easily stopped by setting the packing. The piston rods do not enter the pump cylinder, and are therefore not exposed to the action of the water. The valves are arranged in "pots" so as to be readily accessible by taking off the cover. The valve seats are of bronze, screwed into the casting against a shoulder in such a manner that they cannot work loose. The valves, valve seats and valve stems are of bronze. The piston rods between the high and low pressure cylinders are fitted with automatic adjustable metallic packing that will always remain tight. These pumps are manufactured by Dean Bros., Steam Pump Works, Indianapolis, Ind.



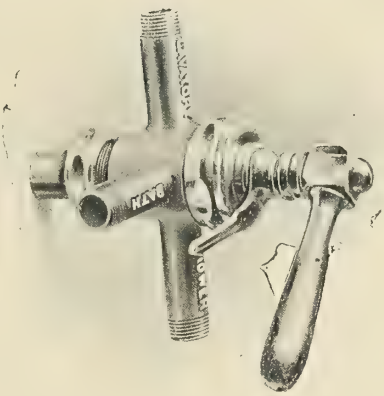
DEAN COMPOUND DUPLEX PLUNGER MARINE PUMP.

Modern Marine Plumbing.

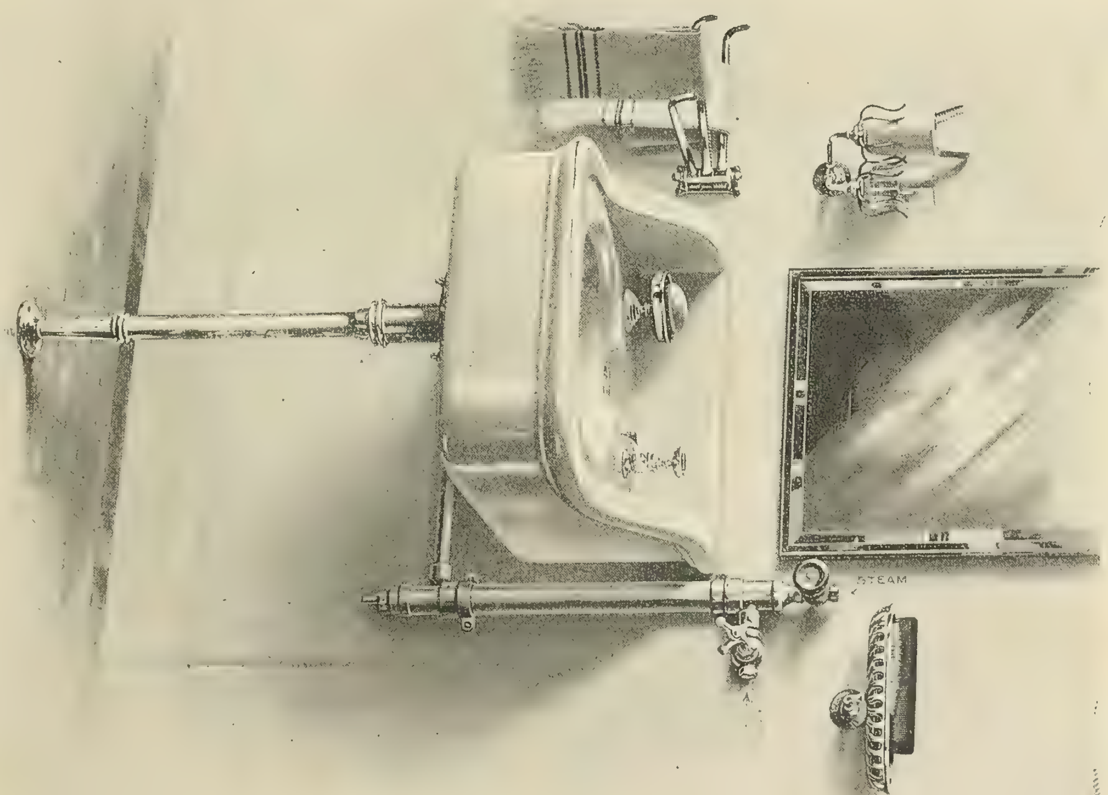
In vessel equipment there has, probably, been greater advancement made in the construction of sanitary appliances in recent years than in any other ship fittings. Special attention has been given to this subject by the J. L. Mott Iron Works, and as a result the artistic productions of their designers have been extensively installed on war vessels, transports, liners, yachts, and harbor vessels of every description. Experience has taught that enameled iron or porcelain baths or lavatories will not remain in good condition for any length of time on shipboard, and thus it has come about that the material styled "imperial porcelain" is used almost exclusively by this company for the better class of fittings. On an adjoining page we show some recent designs put to the test of practical service. The "Imperial Porcelain Lavatory" is one of the most popular for ship use at the present time. It is compact, measuring only 20 in. by 20 in., and is exceedingly strong and durable. It is made with a projecting rim on the inside to prevent splashing, and has nickel plated brass leg, spout, soap cup, plug, coupling, stopper and chain, and patent economic heater. This heater has steam and water connections, so that the supply can be made hot or cold as desired by a simple manipulation of the cocks. It will be noticed, too, that this lavatory is moulded in one piece, so that the objectionable joint between the back and the slab is got rid of. The attention to detail is shown in the wall fittings, which are also of improved form. The towel rack has serrated arms, so that the towels will not slip with the motion of the ship, and also has springs to hold the arms in position wherever they are placed. The glass holders are fitted with springs, thus preventing rattling at sea. The water closet shown is known as the "Wilmington," and represents a rougher class of fitting, for the use of seamen or firemen. It is made of enameled iron, with hard wood seat and with brass non-hammering, slow closing valve. It is very strongly built, and is so simple that it cannot be easily damaged or get out of order. Such closet is sent out with a brace for securing it to the deck and a connection to the hopper. This closet was designed to replace the usual troughs, and it has been fitted in the U. S. gunboats *Nashville, Wilmington,* and *Helena,* and also on the U. S. battleships *Kearsarge* and *Kentucky.* In the engraving of the "Three Way Valve" there is shown a most convenient connection for marine plumbing. By means of this valve in connection with a heater, hot or cold water is delivered to the bath, lavatory, or shower, as required. It is so constructed that while directing the water to any one fixture, it cannot be turned so as to shut the water off entirely. This is an important feature, as it prevents the water in the heater from being so shut in that it cannot expand. In addition to the fixtures here shown, an immense variety is carried in stock by the manufacturers, The J. L. Mott Iron Works, 84-90 Beekman street, New York.



Crew's Water Closet.



Three Way Valve.



Imperial Porcelain Cabin Toilet Set.

TYPES OF MODERN FITTINGS IN SHIPS' PLUMBING MANUFACTURED BY THE J. L. MOTT IRON WORKS OF NEW YORK.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

IN older days of the publishing business the Circulation Fakir was relied upon chiefly to draw public attention to his employer's publication. More wholesome methods have made this office obsolete, though in some unprogressive cases traces of his functions remain. In present days publications which appeal to popular taste have sought to draw attention to themselves by the employment of the Inventor, who is an up-to-date substitute for the Circulation Fakir. This type of Inventor is not content to produce some article or process of real value, secure patent rights, and then endeavor to benefit mankind, and incidentally enrich himself, in a business like, practical way. On the contrary he is usually a cerebrose individual, with a mission; a bombastical genius who has illumed unknown fields of imaginative science with his intellectual searchlight and is willing to permit the gaping world of ignorance or complaisance to peep in and wonder, some credulous editor drawing the curtain. The most brilliant example of the handiwork of such an individual, which has come to our notice recently, is exhibited in the June edition of *The Century Magazine*, published in New York, in the shape of an article—a "preachment" would sound more literary like—entitled "The Problem of Increasing Human Energy," by one Nikola Tesla. This dazzling contribution to modern unscientific research reads like nothing so much as an essay on Christian Science, so profound is it in the ambiguous nothingness whereby it leads through the intricacies of incoherency unto the climax of absolute assininity. This climax is reached for us in the following statement excerpted from page 198 of the June *Century:*

> * * * Steamers and trains are still being propelled by direct application of steam power to shafts or axles. A much greater percentage of the heat-energy of the fuel could be transformed in motive energy by using, in place of the adopted marine engines and locomotives, dynamos driven by specially designed high-pressure steam- or gas-engines, and by utilizing the electricity generated for the propulsion. A gain of from fifty to one hundred per cent in the effective energy derived from the coal could be secured in this manner.

It is no doubt beyond the comprehension of the literary gentlemen who publish *The Century Magazine* to understand that progress in marine propulsion is slow, very slow, and that there is nothing in the entire domain of scientific research that promises any hope of being able to transform a much greater percentage of the heat energy of fuel into motive energy by employing dynamos driven by specially designed high pressure steam or gas engines. It is to be expected, however, that as those responsible for the statements made in what has been considered one of the foremost literary magazines of the country, they should appreciate their lack of expert knowledge and by procuring suitable editorial assistance safe-guard their readers, the reputation of the magazine, and their own sense of right. Under the circumstances we most unqualifiedly pronounce the statement here reproduced from *The Century Magazine*, regarding marine propulsion, as a crude and ignorant fake. It is a question whether such silly stuff deserves any serious recognition, but for the benefit of those who might invest money to further some such project as the application of electric generating sets to the direct propulsion of vessels, we have invited one of the foremost living authorities in marine construction to reply. This reply, written by William F. Durand, of Cornell University, will be found elsewhere in this issue. It is simply a plain statement of scientific truths and the possibilities of the art of vessel construction divested of all mathematical complications, so that even the

untechnical reader can readily comprehend it. We commend it to the serious attention of those in whom the wish is father to the thought, that in some way, by the genius of some poor, miserable human atom, the majestic forces of nature will be cheated of their indivisible and inalienable rights.

BEFORE the adjournment of the Fifty-sixth Congress provision was made in the Naval Appropriation bill for the purchase of armor plate. This clause was in the nature of a compromise between those who take a rational view of the armor plate question and the advocates of a Government armor plate mill. By its terms the Secretary of the Navy is authorized to contract for armor plate for all the armored vessels authorized by Congress, some of which are now under construction, provided that, in his judgment, the price asked by manufacturers is a reasonable one. If, on the contrary, he believes that the price quoted by bidders is excessive, he is directed to establish a Government armor plate mill, for which purpose the sum of $4,000,000 is made available. Following upon the passage of the appropriation bill the Navy Department has issued a circular calling for bids on 31,000 tons of Krupp armor, 3,600 tons of Harveyized armor and 1,150 tons of nickel steel armor. This is for the purpose of completing those armored vessels building or projected, for the protection of which no provision had hitherto been made. These vessels are as follows: Battleships U. S. S. *Maine*, U. S. S. *Missouri*, U. S. S. *Ohio*, U. S. S. *Pennsylvania*, U. S. S. *New Jersey*, U. S. S. *Georgia*, U. S. S. *Virginia* and U. S. S. *Rhode Island*; armored cruisers, U. S. S. *California*, U. S. S. *Nebraska*, U. S. S. *West Virginia*, U. S. S. *Maryland*, U. S. S. *Colorado* and U. S. S. *South Dakota*; protected cruisers, U. S. S. *St. Louis*, U. S. S. *Milwaukee* and U. S. S. *Charleston*. The last named is to replace the warship of the same name lost off the north coast of Luzon, P. I. Only three of these vessels are now under construction, the battleships *Maine*, *Missouri* and *Ohio*. Of the others, those authorized by the Naval Appropriation bill of March, 1899, could not be contracted for owing to a clause in the bill which prevented the letting of contracts for the vessels until the armor had been provided for them. Thus Congress effectually delayed the construction of these ships a twelvemonth. We wonder is it any consolation to those who thus blocked our naval progress or preparedness to read the news of impending troubles in China, which may eventually make a greater call on our naval resources than the Spanish war did. However, at the eleventh hour, as it were, Congress seems to have realized the undignified, even childish, position it had taken on this question, and not only gave the necessary authorization for the purchase of armor, but added to the list of vessels provided by the previous Congress, and agreed upon an expenditure of about $60,000,000 in all on the navy. Though the present shipbuilding programme is a large one, it is not so, relatively, when the advances of foreign nations in naval construction and the rapid growth of our foreign trade are considered. There is cause for thankfulness, however, that the armor plate bogie has been frightened off, and that a fresh start has been made in our naval construction. There is, of course, a great weight of responsibility now resting upon Secretary of the Navy John D. Long to decide whether or not the armor plate contracts will be given to private bidders. The placing of contracts which call for the expenditure of several million dollars of the people's money would, under any circumstances, be a great responsibility, but in this instance the Secretary is invested with almost judicial powers and responsibilities. He must look at the question from many points of view. One point that should be always kept in sight is that the price paid private contractors is for accepted armor, armor that in every respect conforms to specifications. All defective plates, all wastes, all failures in manufacturing processes are at the expense of the contractor. The quality of contractors' armor is real, it has been proven by actual test, while the quality of plate produced in a Government mill is speculative or imaginative. As a common sense business proposition, is it likely that the Government could secure the services of qualified experts in its mill, where work would be carried on only intermittently, as against private employers, whose works are continuously in operation, not, perhaps, in the production of armor plate, but in many other metallurgical processes? There is also the all-important question of date of deliveries, for until the Government works could turn out satisfactory plates all additions to our real fighting squadrons would be at a standstill, while in the case of private contractors immediate deliveries are possible.

Loss of Cunard S.S. "Carinthia."

We here present a photograph of the fine freight steamer *Carinthia*, late of the Boston service of the Cunard line, which went ashore at Point Gravois, Haiti, as reported in our last issue. Latest advices from there are to the effect that the vessel is in a bad way and the chances of saving her are very remote. Several of her crew, officers and men, recently passed through New York on their way home to Liverpool from the wrecked vessel. The mishap occurred while the *Carinthia* was on her way from New Orleans to Cape Town with a consignment of mules for the British Army in South Africa. As the photograph shows, the *Carinthia* had a very pleasing appearance, better in fact than that presented by many passenger boats. She was an exceptionally strong vessel, too, having been designed in accordance with Lloyds 100 A1 class with extra strengthening at the bilge and topsides. She had a good record for economy, having a gross tonnage of about 5,600 tons and dead weight capacity of 7,500 tons, and averaging a consumption of 63 tons of coal per day in regular service.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—II.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

Water-tending. The care of the water is the most important and responsible of the duties in the fire-room. The ideal is to keep the water regularly flowing inward through the check-valves at about the same rate as it is flowing outward as steam through the steam pipe. This requires constant watch and adjustment of the valves, closing down where it is entering too rapidly and opening up where it is entering too slowly. Instead of this method it is often the custom to put the feed on strong first to one boiler and then another, in order, according to the firing, feeding the boiler up when the fire is at its best, and shutting down when it is freshly coaled. The steady and uniform feed is, however, better because it approaches more nearly to a uniform condition of the boiler, especially on the water side.

BROADSIDE VIEW OF THE CUNARDER FREIGHT S. S. CARINTHIA (BOSTON ROUTE) WRECKED AT POINT GRAVOIS, HAITI.

While bound West on May 22, the American liner *New York* broke her port outboard shaft, and the A frame being unable to carry the weight of the tail shaft and propeller broke and both were lost. The mishap occurred without any warning, and the automatic device with which the engines are fitted instantly brought the gear to mid position and prevented a probable repetition of the mishap to the *Paris* some years ago. Steam was crowded on the starboard engine and the remainder of the voyage was made at about 15 knots rate, the liner reaching New York, May 28. It was first intended to send her across for repairs, as the spares were at Southampton, but a careful examination of the starboard engine revealed symptoms of weakness in the crank shaft and the vessel was sent to Newport News for an overhaul.

The position of the water is determined, of course, from the water gauge and cocks. It is necessary, of course, that the gauge and its connections be clear of any obstruction in order that the height of the water may be properly indicated. To make sure that everything is clear the gauge glass and connections are blown through by the "double shut off" method as follows. In Fig. 1 *G* represents the glass, *A* the trip cock, *B* and *C* the cocks connecting to the stand, and *D* and *E* those connecting the stand to the boiler. First, *B* and *E* are closed, and *A* is opened. If steam blows through it shows that *A G C D* are clear. Second, *C* and *D* are closed and *A* is opened. If water blows through it shows that *A B E* are clear. The action of the water in the glass will usually show to an experienced eye whether or not the connections are clear. If the water

is lively and follows the rolling of the ship it is a good indication that the passages are clear. Otherwise it indicates that an obstruction exists which must be sought out without delay. In the meantime the water cocks are relied upon, and in fact many experienced water tenders prefer the indications of the cocks to those of the glass, while they should in all cases be freely used as a check on the glass. To those without experience, however, the glass is less apt to be misleading. The indications of the water cocks are sometimes difficult to interpret, because frequently it is not easy to tell whether water or steam is blowing off. With high pressure steam especially, a jet of water issuing at a temperature of 350 deg. to 400 deg. is instantly surrounded with a shell vapor formed by the vaporization of part of the jet. Furthermore, if the water in the boiler is in active ebullition near to the surface so that the jet would be drawn from a mixture of steam and water, then on issuing it becomes practically a jet of moist steam. On the other hand if the water is well below the cock so that the jet would be drawn from steam alone or from

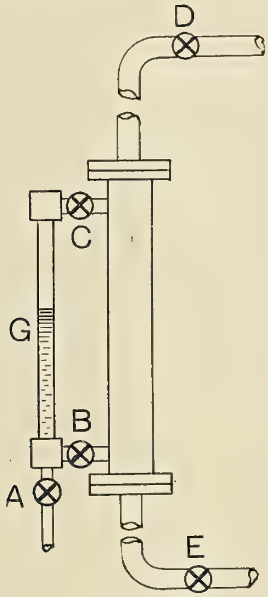


FIG. 1.

moist steam, then on issuing it will become dry and usually super-heated. It is also a fact, especially with water-tube boilers, that due to a kind of lifting action, a cock will often discharge moist steam or a mixture of water and steam, even if the water level is somewhat below the mouth of the cock. It is hence readily seen that the indications from the cocks must be interpreted with judgment, and that some experience is necessary in order to always draw correct conclusions from them. It is often difficult to distinguish between an empty glass and one entirely full. In order to make sure close the cock *B*, Fig. 1, and slightly open *A*. If the gauge is full of water the surface will gradually descend, first coming into view in the top of the glass and then passing out of view at the bottom. If then *A* is closed and *B* is slightly opened, the water will rise again in the glass and pass out of view at the top.

Blowing Off. Blowing off boilers to reduce the concentration or density of the water is now rare in good practice. Instead of reducing density by introducing sea-water for feed make up, evaporators are installed for providing fresh water make up, or for short runs additional fresh water is often carried in spare tanks provided for the purpose.

In modern practice the purpose of blowing off is (1) to get rid of mud or slush in the bottom of the boiler or in the special mud drums of a water-tube boiler, and (2) to get rid of oil and scum at and near the surface of the water. For the former a button blow or special mud cock is required, while for the latter the surface blow is used. In ordinary experience on deep sea voyages where evaporators or other fresh water make up is provided, the use of the surface blow is all that is needed to keep the water in good working condition. It must not be forgotten that the use of the blow-off means a direct loss of heat, and hence it should be used with discretion, and no more frequently than is needed for the purpose in view. An idea of the condition of the water in the boiler near the surface may be obtained by drawing off a little water from a cock fitted into the surface blow pipe, or from a gauge cock fitted directly to the boiler. The water being allowed to cool and settle, is then poured into a glass jar, when its condition is readily noted, and the need of using the blow determined.

It may be well to speak at this point of the proper method of testing, from the outside, the correct position of a plug cock handle for "closed" and for "open." Instances have been known where there was no mark on the head of the plug, and the handle becoming bent or being wrongly placed, the cock was left shut when it was supposed to be open, or open when supposed to be shut, with the possibility of most serious consequences, especially in the latter case.

A careful examination of the cock, aided if need be by placing the ear to the chamber, will suffice to tell whether or not the cock is open and water or steam passing through. Then the cock being open let it be turned in one direction until it is just closed, and then back in the other direction until it is closed again. Half way between these two positions it will be wide open, and at right angles to the latter position it will be full shut.

Taking the Saturation of Testing the Density of the Water.—The density of the water is determined by the use of a hydrometer or salinometer as it is often termed. Under modern conditions where evaporators provide fresh water make up, the density rises but slowly, and it is usually only necessary to observe its value once or twice a day. It is usually not allowed to rise above two or two and one-half.

Disposal of Ashes.—For the disposal of ashes two chief means are in use. According to the older method they are sent up and disposed of through an ash chute leading overboard and down the side of the ship to the water, and this method is still extensively used in large and deep ships. In the more modern system they are disposed of from the fire-room direct by means of an ash ejector. In either system it is usually sufficient to dispose of the ashes once in a watch, and they are collected, wet down and either hoisted in buckets or shoveled direct into the ash hopper usually between 6 and 7 bells.

Cleaning of Fires.—The routine working of fires spoken of above will suffice to keep them in fairly good

condition for several hours, provided the coal is of fairly good quality. It usually becomes necessary, however, to give to each fire from time to time a more thorough cleaning than is possible in the manner previously referred to. To this end the fire should be taken when partly burned down, but not too far lest there be nothing left after cleaning on which to build up again. One side may be cleaned first, working the good coal over to the other side, separating out the clinker and ashes, and hauling out the latter. Then similarly with the other side, working the good coal over to the side first cleaned and pulling out the clinker and ash. The live coal is then spread over the grates fired lightly, and so brought up again into regular condition. In some cases there is so little left after a thorough cleaning that live coal must be borrowed from another furnace to save the fire. Only judgment and experience can determine the best point at which to clean a fire so as to insure the minimum loss of heat, and at the same time have enough coal left to nicely build on again. Some engineers prefer to burn the fire almost completely down to the ashes and clinker, and then pull the entire contents of the grate out and start afresh. This method, however, chills the furnace and more seriously interferes with the operation of the boiler, and is not to be recommended. It must of course not be forgotten that heat is lost with the clinker and ashes withdrawn, and the general operation should be so conducted as to keep this loss down to the minimum possible.

Under usual conditions the fires will need cleaning in this way at intervals of from 12 to 16 hours, or at least once a day.

International Steamship Co.—There is now in process of organization on the Great Lakes a new steamship company, whose operations will be closely watched by maritime interests, both lake and coast. This company is styled the International Steamship Co. In anticipation of its organization a contract was made in April last with the American Shipbuilding Co. for the construction of six vessels as a nucleus of this line. These vessels include three steamers and three tow barges. Two of the steamers and two tow barges will be in commission by Oct. 1, next, and will be operated for the remainder of the season in the Duluth-Montreal trade. Just before the close of lake navigation they will be sent to the Atlantic Coast to engage in the coastwise or deep water trade, according as business demands. The vessels are all of the full Welland Canal size, of these dimensions: Length, 256 ft.; beam, 42 ft.; depth moulded, 26 ft.; maximum load draft, 18 ft. On the Welland Canal draft of 14 ft., the steamers will carry 2,100 tons, and the barges 2,400 tons, and at the 18 ft. draft the figures are: Steamers, 3,600 tons; barges, 3,900 tons. The steamers will be equipped with quadruple expansion engines and independent auxiliaries and B. & W. water tube boilers. The maximum horse power will be 1,500 I. H. P. The hulls of these vessels will be constructed on the usual transverse system with the main deck beams all in place but no laid deck. They will have water bottoms, 4 ft. deep, and in the steamers the machinery will be at the extreme after end, in the usual lake style. Screen bulkheads through the cargo spaces will be made water-tight, and arrangements will be made for carrying water ballast in the cargo compartments when the vessels are running light.

ENGINEERS' DICTIONARY.—XXIX.

Moist Steam—Steam in which there is suspended a certain proportion of water in the form of fine mist. The steam given by the average boiler is slightly moist, the proportion of water very commonly running up to 2 or 3 per cent., and even more in some cases. The term *quality* of steam has reference to the proportion of water. Thus steam with a quality of 2 1-2 per cent means moist steam containing 2 1-2 per cent of water.

Monkey-Tail-Valve—A name sometimes given to a valve which admits high pressure steam into the low-pressure cylinder of a compound, or the intermediate cylinder of a triple or multiple expansion engine. The purpose of such admission is to aid in starting the engine when the high pressure cylinder is on the center. In modern times they are more commonly known as passover or starting valves.

Mud-Box or Drum—A box or drum frequently fitted on water-tube boilers, and usually connected to or forming a part of the lower or feed drum. Its purpose is to form a place in which mud and scale may collect, and from which it may be removed by blowing or by removal from time to time through an appropriate hand-hole or like opening. See also under *Boiler.*

Natural Draft or *Funnel Draft*—Draft which is due simply to the funnel, and unassisted by fans or jets or other means for forcing or mechanically producing a draft.

Nominal Horse Power—A term used in the earlier days of marine engineering to indicate approximately the power which might be expected from a given engine. It was based upon an assumed set of conditions of operation, and was found by an arbitrary rule involving these conditions and certain dimensions of the engine. Watt used the following rule for nominal horse-power:

Power=area of piston multiplied by 896 multiplied by $\sqrt[3]{\text{stroke}}$, and divided by 33,000.

The Admiralty rule was:

Power=area of piston multiplied by speed of piston multiplied by 7, and divided by 33,000.

While a later mercantile rule was:

Power=(diam. of piston in inches)^2 divided by 30.

The term is still used abroad by marine engine builders, to some extent, for commercial purposes.

Non-Return Valve—A general name for a class of valves opening freely and allowing a flow of liquid vapor or gas in one direction, but closing automatically and preventing any return flow in the opposite direction. Feed check valves, pump inflow and delivery valves, etc., are all examples of non-return valves.

Oil Groove.—A groove or small channel cut in the surface of a bearing, and intended to furnish a way whereby the oil may become distributed from the point of supply to the different parts of the bearing as needed.

Oil Hole.—A small hole or channel leading from some convenient external point to the surface of a bearing, and through which oil may be introduced as required.

TECHNICAL PUBLICATIONS.

A Manual of Naval Architecture. By Sir W. H. White, K. C. B., Director of Naval Construction, Admiralty, London. Fifth Edition, 1900. New York, D. Van Nostrand Co. Size 6 by 9 1-2 in. Pages 731. With 176 figures. Cloth, $9.00.

This edition of *White's Naval Architecture* seems to be the same as that of 1894, with the addition of two pages of matter distributed between pp. 166 and 176, and relating to the influence of bilge keels on rolling. So far, therefore, as a review of new matter is concerned, it would be only necessary to refer to these additions to the chapter treating of the rolling of ships. This book, however, has justly attained to so high a place in the estimation of the marine public, that it may not be without interest to examine it briefly as a whole, and as it now stands.

In the author's preface it is stated that the book has from the first been chiefly written for the use of officers of the naval and mercantile marines, and as an introduction for students of naval architecture to more formal and mathematical treatises. It was also expected to serve as a book of general reference for naval architects, ship-builders and marine engineers. The plan thus laid down by the author has been consistently followed from the first, and the work as a whole is therefore descriptive and general rather than formal and complete in any one branch of the subject. The purpose of the author has apparently been to give an intelligent idea of the nature of the more important questions and topics which come up for consideration in connection with the design, construction and propulsion of a ship, but without going into the detail of methods for actual or quantitative computation, except incidentally or for roughly approximate purposes. Thus, while *displacement, tons per inch*, and like geometrical properties are described and illustrated, no methods are given for their actual computation. Similarly with the subject of *stability*, a general and elementary exposition is given of the theory with a large amount of illustrative matter, but without reference to detailed methods for its computation under any given set of conditions. Again, in the discussion of the screw propeller, the theory is developed in some detail, various experimental investigations are described, and a large amount of general information is given in a very interesting and instructive manner, but without rules or methods for actually designing or proportioning a propeller to meet the requirements of a given case. Again, the theoretical development is throughout quite abridged, and the student will note the omission of many points presumably not considered necessary for the purposes of the author. These points are referred to not in criticism, but simply to show from what standpoint the author has carried the work through.

As a whole the book is divided into eighteen chapters, and due to the limitation of space only a passing reference can be made to some of the more important features of these sub-divisions of the work.

In Chapter I the general subjects of displacement, buoyancy, and the fundamental theory of a floating body are taken up. Loss of buoyancy by the flooding of compartments and sub-division by bulkheads are also considered, and an interesting historical summary is given of the subject of load-line and freeboard legislation and rules.

In Chapter II the subject of tonnage is treated quite fully, both historically and with reference to the various points involved in the subject as determined by the present existing laws and regulations. Chapter III is devoted to the subject of the statical stability of ships, as referred to in the foregoing introductory remarks.

Chapter IV is devoted to the subject of the oscillations of ships in still water. A portion of the elementary theory is given in a general or descriptive manner, while the subject of the influence of bilge keels is considered in some detail. It will be remembered that experiments on British battle-ships of the *Royal Sovereign* class showed that the effect of bilge keels was enormously greater than had been expected or estimated by the use of the formulæ and co-efficients usually employed for such purposes, such co-efficients being derived from experiments on the resistance to the motion of planes through water in a direction at right angles to the surface. The new matter added in this chapter has chiefly reference to these battle-ship experiments, both on the actual ships and on models, and to the possible basis of an explanation of the discrepancy. In regard to the latter point special emphasis is laid on the wave-making action of a bilge keel, and the consequent increase in the resistance to its motion, as possibly accounting in large measure for its increased efficiency. On this point reference may be made to a paper recently read before the Institution of Naval Architects by G. H. Bryan, F.R.S., on this same point, in which the added resistance is considered as due to the development of discontinuous motions in the water as the keel swings through it to and fro. While the author seems to have been disposed to bring this particular chapter down to actual date, he has apparently overlooked the interesting and important experiments made in 1895 in the Italian experimental tank at Spezia on a model of the *Sardegna*, and which showed results of a character similar to those in the English experiments quoted.

Chapters V, VI and VII are devoted to the subjects of deep sea waves, the rolling of a ship among waves, and methods of observing the rolling and pitching of ships. These chapters are chiefly descriptive, though here and there the elementary results of theory are given. They present the subject in an interesting and instructive manner, and are especially intended to awaken in the sea-going officer an intelligent interest in the waves of the sea, the motions of his ship among them, and the methods of making and recording observations and records of such motions.

In Chapters VIII and IX are discussed the strains experienced by ships, their structural arrangements, and the general question of strength. The cause of sagging and hogging stresses is clearly explained, and a general description is given of the method of computing the moment of inertia of the structural section. For the latter, illustrative computations are given, though it may be regretted that they are based on a diagram of the equivalent girder section rather than directly on the structural section itself. The diagram of the equivalent girder may be of value for purposes of illustration or instruction, but it is of no advantage for the actual com-

putation, which in all usual cases may be better made direct from the structural section itself.

In Chapter X the subject of shipbuilding is taken up in a brief way, the purpose being chiefly to show the distribution of the various members in the structure of a ship, and the manner in which they take their part in the formation of the ship as a whole. Unnecessary prominence is perhaps given to iron as a material for ship-building, and to comparisons showing the advantages of steel over iron. At this day we do not need such comparisons, though they may perhaps have been more appropriate in 1894.

In Chapter XI the subject of the resistance of ships is treated from the descriptive and general standpoint. The more important theories and their consequences are stated and discussed, and their bearing on the general subject of resistance is brought out. Especial prominence is of course given to the experimental work of the late Wm. Froude and of his son, R. E. Froude. The law of comparison is explained and its use in the estimation of resistance is illustrated. Air resistance and the modification of resistance due to waves are also briefly considered.

In Chapter XII propulsion by sails is considered, the accepted theory as based on the laws of wind pressure being discussed, and various practical and empirical results relating to the location of the sails, amount of sail area, etc., are given.

Chapter XIII deals with the general question of steam propulsion, propulsive co-efficients, and the interaction between ship and propeller. Some reference is also made to the subdivision of the work developed in the cylinders among the various items, and the bearing of these various parts on the general problem of propulsive efficiency is considered.

In Chapter XIV the author considers recent progress in marine engineering and its influence upon steamship design. An interesting and comprehensive summary is given of the progress due to forced draft, water-tube boilers, the use of steam of continually advancing pressures in multiple expansion engines, increase in piston speed, reduction of weights by improved design, increase in engine efficiency, etc., etc. This chapter is naturally of an accessory or supplementary nature, so far as the main purpose of the book is concerned, the object being simply to give a brief but comprehensive view of the relation of the art of marine engineering to the general problem of steamship design. While well up to date for 1894 this chapter is, as noted below, somewhat behind the times for 1900.

Chapter XV deals with the subject of marine propellers, and contains a general and descriptive discussion of the paddle-wheel and screw propeller with reference to the attempts to use water-jets on the *Waterwitch* and *Hydromotor*. A brief exposition is given of the theory of the screw propeller from the Rankine standpoint, that is, by a consideration of the mass of water acted on and the acceleration impressed upon it. The theory developed is understood of course to apply only to certain ideal conditions, and a reference is made to the general character of the influences which modify these simple ideals. There is perhaps a danger that sufficient prominence has not been given to the latter points, and that the reader not already well grounded in this part of the subject might gain the impression that the simple theory as given is reasonably complete and ample for practical or working purposes. As a matter of fact, it is of almost no use whatever from the direct designing standpoint, the actual design of propellers being entirely based on empirical formulæ derived either from actual experience or from experimental results on model propellers, rather than on abstract theory. These points are indeed considered later in the chapter, and extended reference is made to the work of R. E. Froude and others in the experimental field, and to the use of their results as a basis of screw propeller design, though the actual methods are not given.

In Chapter XVII the subject of estimates for the horse power and speed of ships is considered, with some general notice of steamship efficiency. The two "admiralty" co-efficients (midship section and displacement) are considered, and their use is explained. Rankine's augmented surface method is also brought forward, simply, it may be supposed, as a matter of historical interest, and because the author hesitated to omit from his pages a method backed by so notable a name. The method by the use of the so-called extended law of comparison is also briefly considered. A much fuller reference to this method and to its relation to the use of the admiralty co-efficients might with advantage have been included.

In Chapter XVIII and the last the author deals with the steering of ships. This subject is naturally one in which both the designer and the sea-going officer are keenly interested. The elementary theory of the rudder is given, together with an interesting historical summary referring to various forms and varieties of rudder and steering gear which have been proposed from time to time. The interaction between the propeller and the rudder and the influence of the former on steering are also considered. Reference is also made to the path followed by a ship in turning, and to the methods for determining this path by practical observations. As a whole this chapter covers a wide range of most interesting and valuable matter presented in a clear and instructive style, and apparently brought well down to the date of publication in this form.

The chief disappointment with the present edition of the work as a whole is that it is not brought down to 1900 rather than 1894. The demands upon the time of the distinguished author are of course understood, but it is to be greatly regretted that having such exceptional opportunities for obtaining the most accurate information upon all subjects in this field, it has not seemed possible to introduce the many important and valuable results which have been brought forward during the past six or seven years.

Thus, during that time the magnificent experimental tank at Washington and its equipment have been completed, and work has been under way for the past year, while it is understood that the equipment of the tank at Cornell University is also well under way, and that work of research character will be soon commenced. In the chapter on steamship efficiency, the influence of modern full powered liners is inadequately referred to, as well as the exceptionally high efficiencies seemingly reached by torpedo boats and craft of the like class.

On the subject of the screw propeller also, there has been accomplished in the past six or seven years some interesting and valuable work both experimental and

theoretical, which might well have found a reference in the pages of this book. In referring to the extreme speeds of torpedo boats the statement is made on page 470 that "vessels of 180 and 200 feet have been driven at 27 knots." From 27 to 35 knots is a long step, but it has been accomplished during the past six years. In marine engineering notable advances during these years have been made in piston speeds, in steam pressure, in the use of forced draft, and especially the extension of the use of water-tube boilers. In fact, the recent wide extension of their use in naval practice which has resulted in their gaining general recognition in one form or another as the accepted type for nearly all classes of war ship design has almost wholly occurred during the past five years, and would never be suspected from the pages of this work in its present form.

The point of the whole matter is, that the fifth edition of this notable work in practically all that relates to modern and up-to-date practice is from six to ten years behind the times, the practice referred to being that of the eighties and early nineties, rather than that of the late nineties. Principles are eternal, but practice changes and grows, and so far as the entire practical side of the book is concerned it falls short of the usefulness which it might have, simply because the obsolete and out-of-date has not been pruned away and replaced by the modern and up-to-date information representing the practice of the latter part of the present decade.

In so far as the work is intended to be historical or to give brief historical summaries, of course reference to the past and its contributions to the present must be made, but for him who wishes to know the art as it actually exists to-day, practice of a more recent date than that given in this work must be at hand.

From the standpoint of 1894, however, it is a pleasure to characterize this book on the whole as a most notable and valuable contribution to the literature of the subject of marine construction, and its wide circulation and the high estimation in which it has been held are the best evidences of the manner in which it has occupied the field of usefulness held in view by the author in its preparation.

Mechanics' and Engineers' Pocket Book of Tables, Rules and Formulas. By Charles H. Haswell, M. E. Sixty-fifth edition, 130th Thousand, 1900. New York, Harper & Bros. Size 4 by 6 1-2. Pages 1,045. Leather, flexible covers, with flap and pocket, $4.00.

The first edition of this pocket book, published in 1843, was the pioneer book of its class in this country, and among such books of reference none have enjoyed so long a period of usefulness and favor with the engineering public as this. Its venerable author, the acknowledged Nestor of the profession, early saw the value of collecting together and placing in convenient form such items of information as might serve to answer the thousand and one questions arising at every turn in the engineer's practice of his profession, and the first edition, published now 57 years ago, was the result of that wise insight into the needs of the times. The steadily increasing size of the book from the first, and the growing demand which it has as steadily met, are the best proofs of the wide field of usefulness for such works, and of the manner in which this book has occupied the field.

In keeping up the successive editions of such a work of reference, however, there is a danger that it may be allowed to fall somewhat short of the march of actual progress, and that the obsolete and out-of-date may not be discarded with sufficient vigor, so that as new matter is added and time goes on, the work may become impaired by a mixture of the old with the new, the discarded and the discredited with the modern and authoritative.

From the marine standpoint the parts of the book of chief interest are those on naval architecture and marine engineering, including some reference to screw propellers. For the purpose of the naval architect or marine engineer of to-day the information given under these heads is of very small value. In large measure it is entirely out of date, no small part of the theoretical formulæ have never had any standing or practical value whatever. It is quite impossible to enter into complete details as it would require many times the space available for a review, and therefore a few illustrations must suffice.

Thus on p. 663 reference is made to the estimate of the late William Froude that about 37 to 40 per cent of the I. H. P. was effective in propelling the ship. Under modern conditions this proportion has risen to from 55 to 60 per cent and over. On p. 647 the mathematical formulæ for the resistance of different geometrical bodies moving through a liquid are inadequate and of no practical value, and have never had any standing with those having to deal with the practical side of the profession. On p. 662 the proportions relating the pitch ratio of screw propellers to the ratio between their disc area and the mid-ship section seeks to establish a relation where none of a definite character can exist. Again on pp. 886-889 the data for the most part refer to old or obsolete vessels, such, for example, as the United States cruisers *Maine*, *Chicago* (with old machinery), *Vesuvius*, the English torpedo boat *Sunderland*, cruiser *Archer*, the Spanish cruiser *Reina Regente*, etc., etc. On p. 896 are given various runs of sidewheel paddle steamers, the latest being of date 1870, representative boats being the *Daniel Drew*, *Mary Powell*, *R. E. Lee*, etc.

The book is accompanied by an appendix of about 100 pages, in which information on the widest variety of topics is given without reference to arrangement or order. A portion of this matter relates to marine engineering, in part data from recent experiments, as, for example, the trials of a Babcock and Wilcox boiler for the U. S. S. *Alert*, and in part matters of historical interest only, as, for example, the Emery experiments on the economy of the steam engine.

Illustrations of these points might be largely multiplied, and it is not too much to say that in so far as the value of the information given depends on its being representative of modern practice, these sections, to be of practical value to the naval architect or marine engineer, would require an entire revision, and a replacement of most of the matter given by new and up-to-date information.

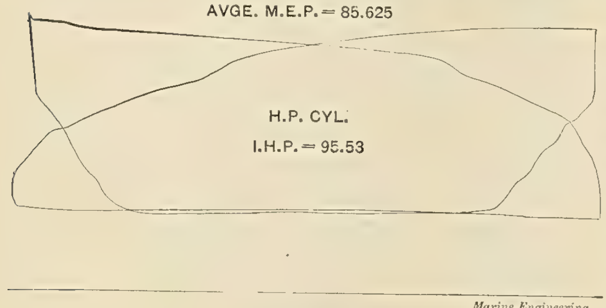
Signor Marconi, who has developed a system of wireless telegraphy, is now in this country.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

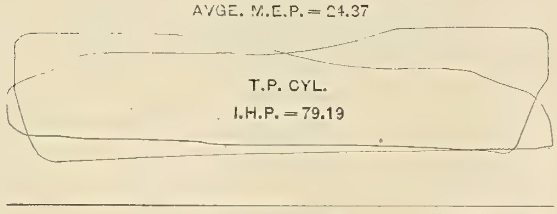
Q.—I enclose a set of triple expansion cards and would like to know where I can make improvements on the engines. The valves have link motion, and they are piston valves, one for the H. P., and one for the I. P., and two for the L. P. cylinders. They take

AVGE. M.E.P. = 85.625



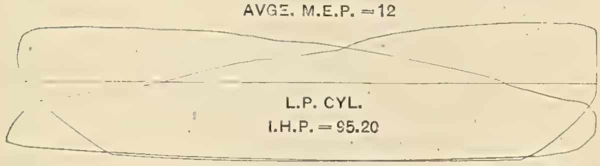
SCALE 100 LBS.

AVGE. M.E.P. = 24.37



SCALE 40 LBS.

AVGE. M.E.P. = 12



SCALE 20 LBS.

CARDS REDRAWN TO REDUCED SCALES.

steam through the valves and exhaust around them. I think the cards are fairly good. The engine has cylinders 9 3-8 in., 16 in. and 25 in. dia., and 16 in. stroke. When the cards were taken the engines were making 200 revolutions, with boiler pressure 170 lb. and vacuum 20 in. by the gauge. O. D.

A.—The cards you send represent fairly good triple expansion work, in fact rather better than the average. We note the H. P. card has the scale marked 140; this is an error, as it should be 100. The card is good and shows a pressure of 164 lb. at the beginning of the steam line, which is a drop from boiler pressure of only 6 lb. The pressure at the point of cut off is about 144 lb., showing a loss of 26 lb. from boiler pressure. The cause of this is due to contraction in the steam parts, and is a common failing and one that cannot be easily remedied. As the boiler pressure in the I. P. card is 175 lb. it is evident that the diagrams were not taken simultaneously, so the losses in the receivers cannot be ascertained. Probably the cards were taken one after the other, as quickly as the indicator could be shifted, and no doubt they represent the average work performed. The I. P. card looks irregular, owing to the drop in the exhaust on the crank end. This drop is due to a difference in cut off of the two ends of the L. P. cylinder. The L. P. card is good, and it also gives a good vacuum, but as already stated, the head end cuts off later than the crank end. This could be remedied very easily by giving the valve a little less lead at the head end and increasing the lead at the crank end—in other words, shift the valve very slightly. This would reduce the compression at the head end, and increase it at the crank end, and would balance the two ends of the card very nicely.

Working up the cards gives the following results: H. P.=95.53 I. H. P.; I. P.=79.19 I. H. P. and L. P.=95.20 I. H. P.—a total of about 270 I. H. P. You will notice that the I. P. card shows the least power, but the powers are all pretty well balanced as far as is practicable, and any alteration to this effect would not increase the efficiency of the engine to any extent.

If your engine has a linking in gadget on the I. P valve gear, it would be well to link it in a little, giving the I. P. a shorter cut off, and an increase of power in the I. P. cylinder would result and the H. P. would be decreased a corresponding amount, and the respective powers would even up to about 88 I. H. P. each. This would increase the pressure in the first receiver about 4 or 5 lb.

Q.—Please answer the following: What would be the best thing to do if the H. P. piston ring of a compound engine would break at sea, and would it be well to try and patch it? If it could not be patched, what would be the best to do? Also would the same remedy apply in the case of the L. P. piston, and supposing there was no spare on board? E. G. W.

A.—The best thing to do with high-pressure piston rings, if they broke at sea, would be, in the case of Ramsbottom rings, to continue to use them if they were not broken in more than two or three pieces. If, however, they were broken into a greater number of pieces, holes should be bored in each end of the broken pieces and dowel pins inserted. This is the only way that a small Ramsbottom ring can be repaired. Should the rings be worn, leaving a space of 1-4 in. or more at the back of the ring, a piece of asbestos tape should be wrapped around the bottom of the groove so as to fill up this space and keep the ring from being driven into the groove, which is often the cause of these rings breaking. In the case of a deep flat ring, the simplest way to patch it would probably be to attach a plate to it on the inside, if there was room for this. Where there is not room for a patch to go on the inside of the ring, the simplest way to hold the parts together is by putting in dowel pins, as already recommended for the Ramsbottom ring.

Of course in all such cases as this, the ingenuity and ability of the engineer come into play, and he must be guided, to a great extent, by the circumstances in what he attempts to accomplish. He is also limited, to a great extent, in what he can do by the tools and material at his command. The same remedies would apply to low pressure pistons, but in the event of the low-pressure piston packing ring being entirely destroyed, a very good packing can be made of manila or hemp rope material that can always be found on shipboard and which has been used for this purpose in times past.

Q.—If a manganese bronze casting were fastened to a wooden hull by ordinary brass screws, would there be any serious corrosion of the screws due to the action of sea water and proximity to the manganese bronze?

If a tobin bronze casting had copper bolts fastening it to a wooden hull would there be any serious corrosion to either metal due to sea water or their proximity? SUBSCRIBER.

A.—There is not sufficient electro-chemical difference between manganese bronze and ordinary brass, or between tobin bronze and copper, to give rise to any noticeable corrosion in either of these cases.

The case liable to give serious trouble due to electro-chemical action is when iron or steel is in contact with copper or with a bronze very rich in copper, and both are in contact with the sea water. In such case electro-chemical action is set up and the operation goes on at the expense of the iron or steel, which thus becomes rapidly corroded.

Craft's Tables of Plate and Rivet Values for use of boiler designers, boiler makers, inspectors and engineers, to assist in designing and calculating the efficiency of boiler joints, has been issued in convenient form (folding boards) by Thomas H. Craft, 16 Kelton street, Cleveland, Ohio.

MARINE ENGINEERING.

Vol. 5. NEW YORK, AUGUST, 1900. No. 8

MAIDEN TRIP OF THE HAMBURG-AMERICAN S. S. DEUTSCHLAND.

In Marine Engineering for July were published views of the engines, boilers and crank shaft of the new Hamburg-American liner *Deutschland.* The long looked for maiden trip has now been run, and a new set of records has been established. The contract for the ship called for a speed of 23 knots and it seems not too much to believe that this figure as an average speed will be not only reached but even exceeded when the machinery has become adjusted and settled into good working condition.

HAMBURG-AMERICAN COMPANY'S TWIN SCREW S. S. DEUTSCHLAND.

The *Deutschland* left Plymouth on July 6, at 10.51 P. M., and arrived off Sandy Hook on July 12, at 10.15 A. M. The total distance run was 3,044 knots and the average hourly speed 22.42 knots. The daily runs were as follows: 308, 557, 553, 551, 532, 543. There are no records from Plymouth to Sandy Hook, but the distance run is almost the same as that covered on the maiden trip of the *Kaiser Wilhelm der Grosse* from the Needles to Sandy Hook—3,050 miles, which required 5 days, 22 hrs., 35 mts., giving an average speed of 21.39 knots. The *Deutschland* has also beaten the best western run of the *Kaiser Wilhelm der Grosse* which was made in November last from Cherbourg to Sandy Hook at an average speed of 22.19 knots.

On the home run eastward the results were still more gratifying, and new records in this direction have also been established. The distance run from Sandy Hook to Plymouth was 3,085 knots, and the time was 5 days, 14 hrs., 6 mts., giving an average speed of just 23 knots for the trip. The daily runs were as follows: 536, 534, 515, 530, 535 and 435. The previous Sandy Hook-Plymouth record eastward had been held by the *Kaiser Wilhelm der Grosse,* made on her first trip in October, 1897. The time then required was 5 days, 15 hrs., 10 mts., over a distance of 2,962 knots, giving an average speed of 21.91 knots. The new record betters the time by 1 hr. and 4 mts., over a slightly longer course, making a gain of 1.09 knot average speed for the run.

It thus appears that the *Deutschland,* with her displacement of 23,000 tons and speed of 23 knots, represents a notable advance in fast ocean steamships, and her career in the immediate future, or until her laurels shall be transferred to some new ocean wonder, will be watched with the liveliest interest.

FAST PASSENGER STEAMER ANGLIA.

In the accompanying photographs of the S. S. *Anglia,* the most recent addition to the extensive fleet of the London & Northwestern Railway, operating in the Irish Sea, is shown. For many years the paddle steamer held its own in those waters to the exclusion of screw vessels, but since the handiness and economy of the twin-screw vessel have come to be recognized by the conservative officials of the various lines, the modern type has rapidly displaced the older side-wheeler. The latter did not succumb without a fierce struggle, and this has been the cause of vessels with single expansion engines and about 30 lb. steam pressure running in the same service with vessels fitted with triple-expansion engines and modern high pressure boilers.

The service which the vessel shown is engaged in is the carriage of passengers from the port of Dublin to the terminus of the London & Northwestern Railway at Holyhead, across the Channel in Wales.

The new vessel is a product of the famous Denny Yard, at Dumbarton-on-the-Clyde. She is a twin-screw vessel, built of mild steel, of these dimensions: Length, 337 ft. 6 in.; beam molded, 39 ft.; depth to awning deck, 24 ft. 9 in.; draft, 11 ft. 9 in.; tonnage, 1,862 tons. It will be seen that the draft is light. This is occasioned by shallow water at both ends of the run, and the chief difficulty, perhaps, to be overcome by the designer, was to get the required high speed within these limitations. On her trial trip on two separate runs of 100 knots, a mean speed of 21.5 knots was attained. In her regular service the cross-Channel passage is about 64 knots, and the rate of speed not less than 20 knots. On her first cross-Channel trip the wind was exceedingly strong on the port quarter and the sea very rough," and the rate of speed was 20.5 knots, with 178 engine revolutions per minute—the same as on the trial which took place in smooth water. On the trial trip the boiler pressure was 160 lbs. and the I. H. P. developed 7,000. The propelling engines are of the four-cylinder triple-expansion type, balanced on the Schlick-Yarrow-Tweedy system.

Outside of the machinery spaces the entire vessel is practically occupied by passenger accommodations, with furnishings and fittings such as are usual in British coastwise steamers of this class.

MAIN SALOON, S. S. ANGLIA.

SECOND-CLASS SALOON, S. S. ANGLIA.

EQUIPMENT FOR HANDLING BULK CARGOES RAPIDLY AT GREAT LAKE PORTS.—II.*

BY ARTHUR C. JOHNSTON.

When railway cars are always available "direct unloaders" are used to transfer the ore directly to cars. The latest plant of this kind is that shown in Fig. 9 and in Fig. 10, built by the McMyler Mfg. Co. for the Pittsburg and Conneaut Dock Company, at Conneaut, Ohio. These machines have attracted a great deal of attention and a description of their equipment will be of interest. Each machine, complete in itself, carries three bridges, which can be racked in and out to suit any spacing of hatches from 21 to 36 ft. centres. The bridges cover five loading tracks, and are high enough to accommodate the largest Lake vessels. An 80 H. P. locomotive type boiler supplies steam to three pairs of 10 1-2 in. by 14 in. reversing engines. Each pair of engines has 40 in. drums for both hoisting and trolleying, mounted on the crank shaft, the wagon having a three part hoist. A feature of the arrangement of the engine is the method of controlling the clutch and brake for the trolleying drum—using a steam cylinder, which when it sets the brake at the same time releases the clutch, and vice versa. Cables 9-16 in. dia. are used for hoisting, running on 24 in. sheaves except in the wagon where they are 17 in. and in the hanging block 15 in. dia. It is made impossible for a rope to leave the sheave by the use of the very simple guard shown in Fig. 11. The machines can travel along the dock by steam and the racking of bridges is also effected by the engines. All movements other than hoisting and trolleying of the bucket are accomplished by means of a jack shaft driven by a pinion on the crank shaft of the main engines. Under actual working conditions the capacity of the plant of twelve bridges at Conneaut is 6,000 gross tons per day.

Fig. 12 is a photograph of a similar direct unloading plant built by the Brown Hoisting and Conveying Machine Company on the C. & P. docks at Cleveland. The drum is geared to the crank shaft and the "suspended hook" is used. In neither the Brown nor the McMyler direct unloaders is the hanging block locked in the wagon except to obtain the maximum clearance under the bucket. The lock on the wagon is very handy, however, to hang empty buckets from when the machine is idle.

FIG. 9. MCMYLER DIRECT UNLOADER.

With all these machines in which the buckets are filled by hand, the actual cost of handling the buckets is very small, varying according to how nearly up to its full capacity a machine is worked; but under actual working conditions from figures prepared by A. E. Brown, the cost per gross ton of ore handled by his machine varies from .70 cents to 1.37 cents. But the greatest expense is incurred in filling the buckets. The shovelmen are paid from 10 1-2 cents to 13 cents per gross ton, so that at an average rate of 11 cents per ton it cost $1,980,000 for shoveling, to unload the 18,000,000 tons of ore shipped this year. It was to re-

*A paper read before the Civil Engineers' Club of Cleveland and contained in the Journal of the Association of Engineering Societies.

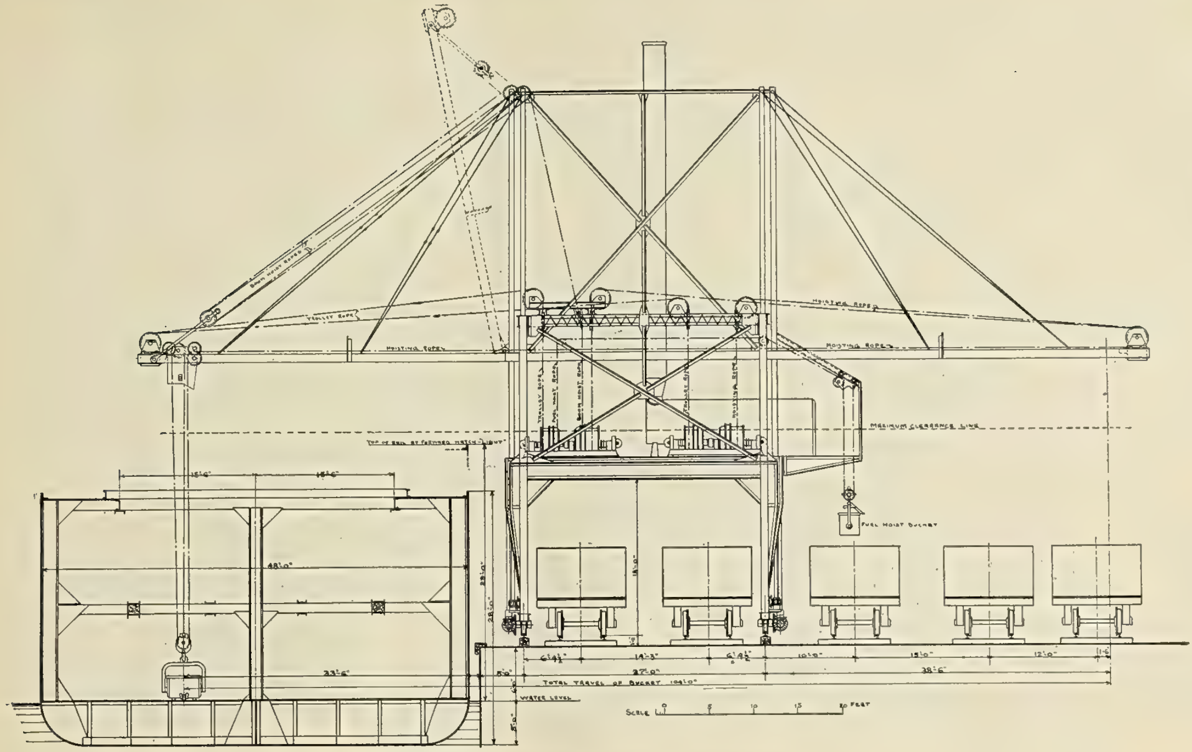


FIG. 10. McMYLER DIRECT UNLOADER.

duce this cost that the Hulett ore unloader shown in Figs. 13 and 14 was designed and built by the Webster, Camp and Lane Machine Company for the Pittsburg and Conneaut Dock Company at Conneaut. Up to the present not enough has been done with this machine to obtain any data in regard to its performance. Its method of operation will be evident, however. The bucket is designed to lift 10 tons of ore at one scoop and dump it into the railway cars, or into a skip which can deliver it onto the stock piles. All the motions on the trolley carrying the tilting girder are effected by hydraulic power—the pumps and tank being carried in the trolley itself and the steam loaded accumulator is used to partly balance the weight of the bucket. The operator is located just above the bucket, and descends into the hatch with it. The bucket can rotate in either direction about the axis of the vertical ram, thus enabling the ore lying in between

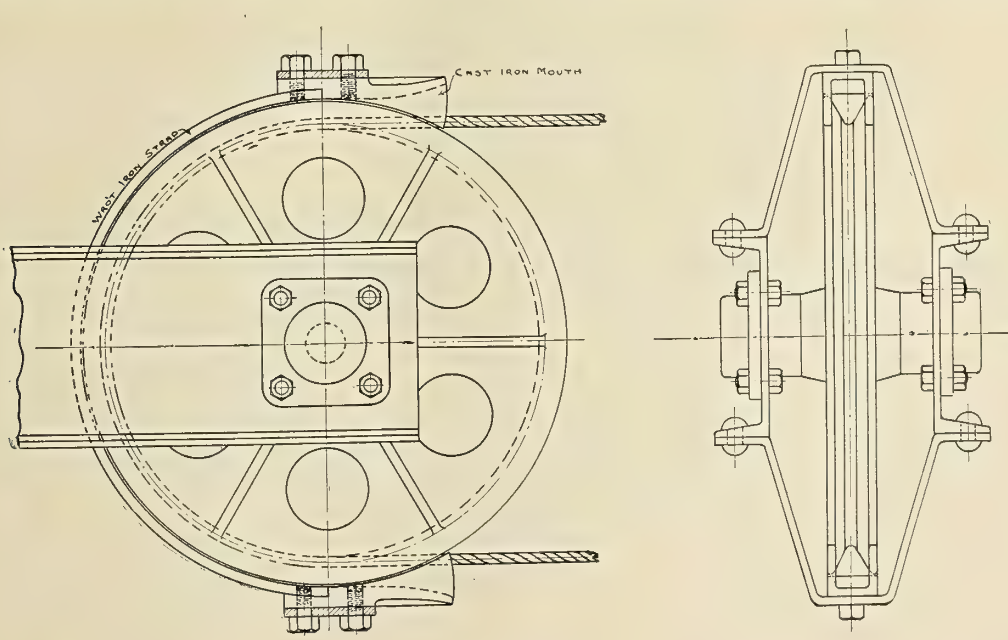


FIG. 11.

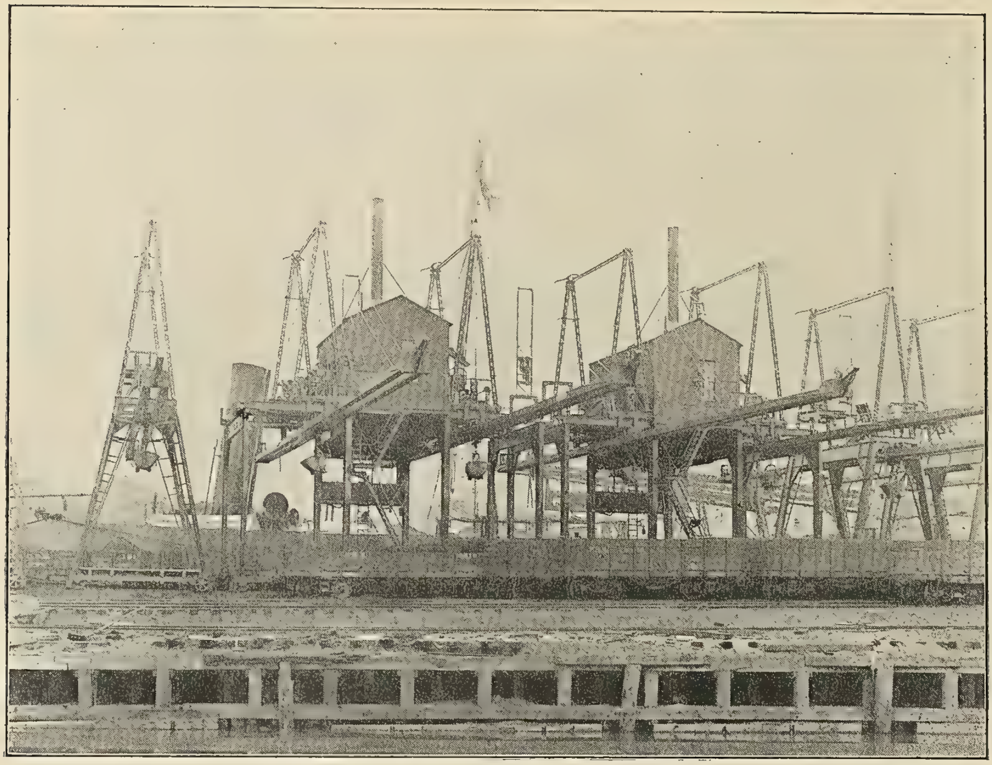


FIG. 12. BROWN DIRECT UNLOADER.

hatches to be reached. It is expected that very little of the ore will have to be shoveled by hand with this machine.

The large vessels returning from the lower lake ports go up in water ballast or take a return cargo of coal, and to facilitate the loading of the enormous tonnage that is carried to the upper lake ports each year, the car dumper has been developed—a machine which picks up bodily a car weighing 17 1-2 tons and carrying 40 tons of coal, and empties the contents into the hold of a vessel at the rate of as high as 30 cars per hour. Fig. 15 shows the first type of McMyler "side dump" machine

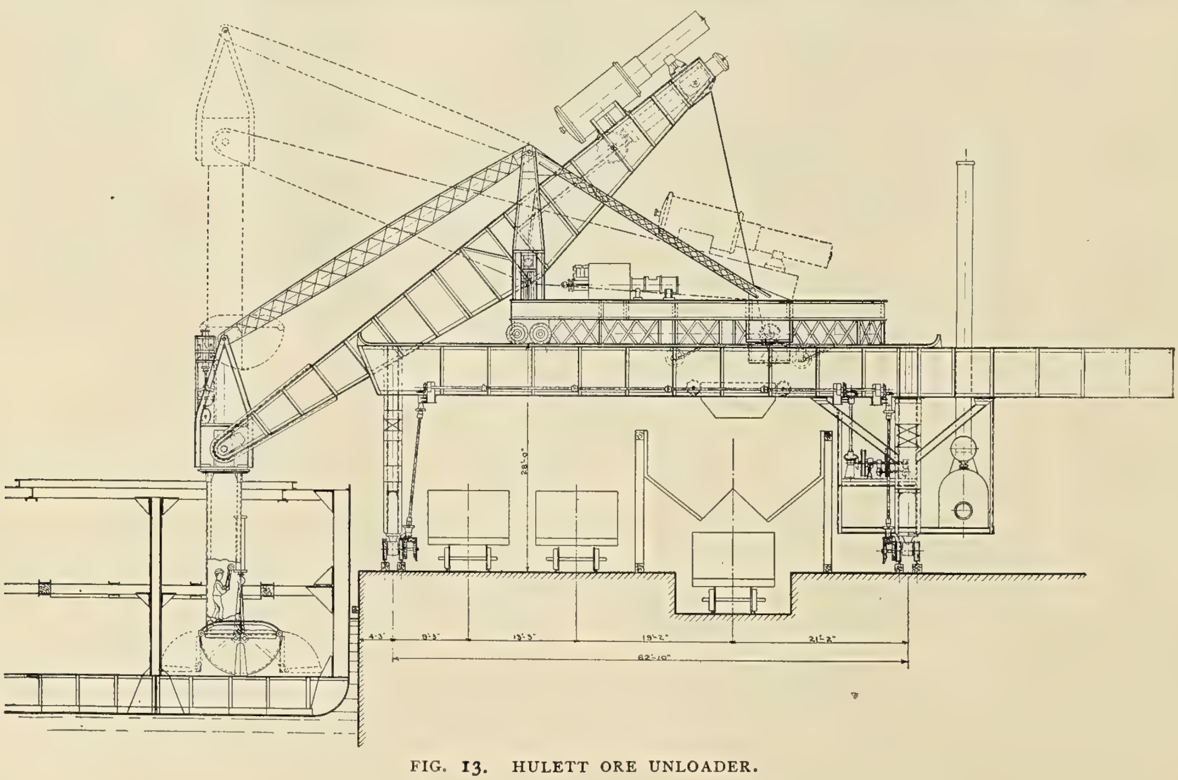


FIG. 13. HULETT ORE UNLOADER.

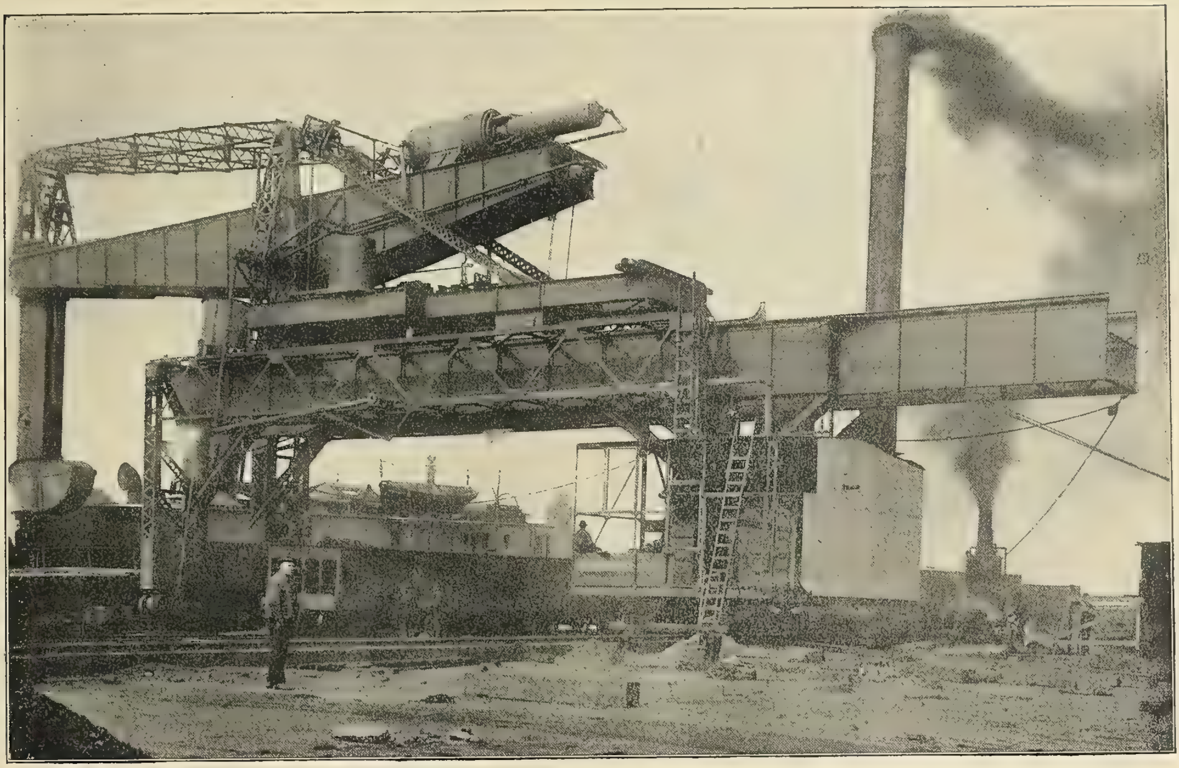


FIG. 14. HULETT ORE UNLOADER.

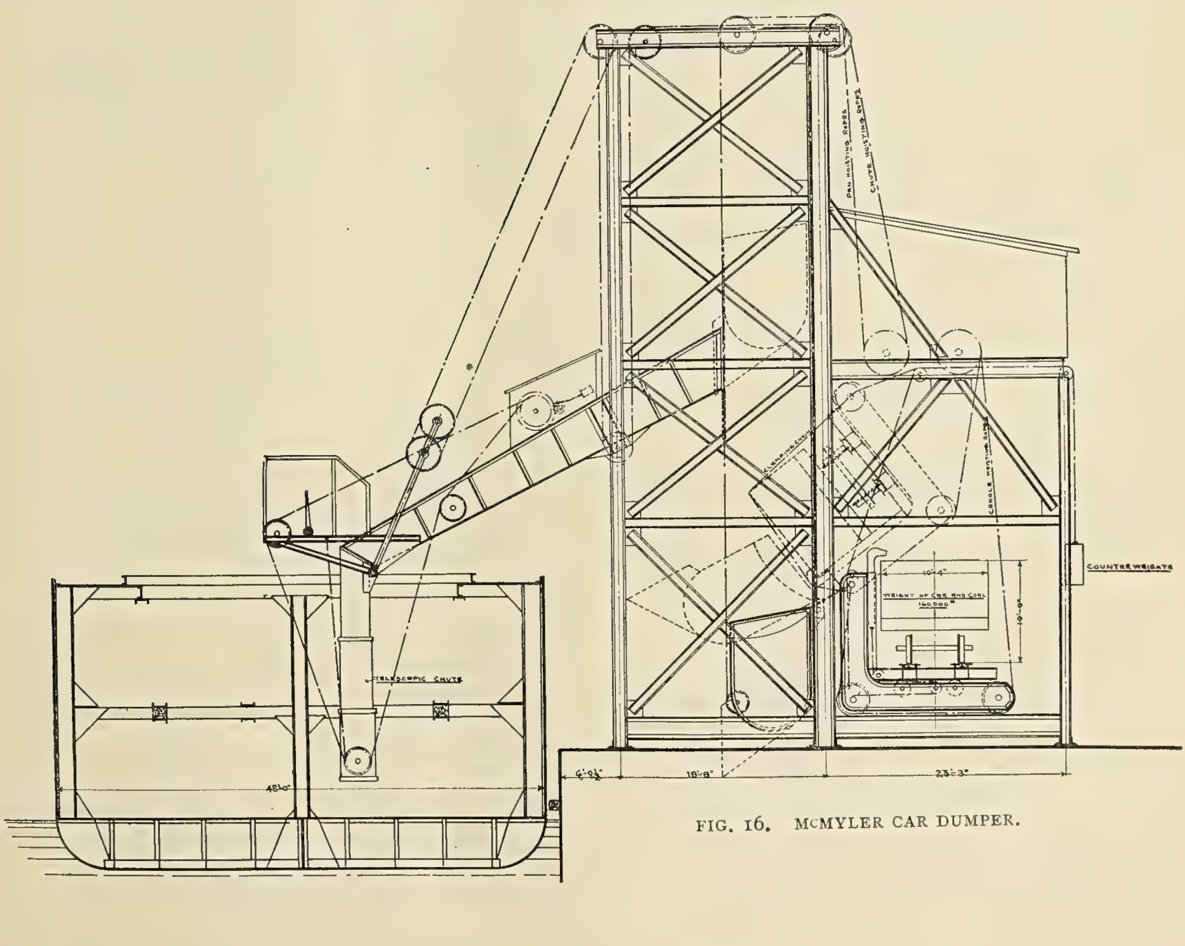


FIG. 16. McMYLER CAR DUMPER.

built on the lakes. The first successful machines were of the "end dump" type, but they require special cars and are still in operation, one at Ashtabula and one at Fairport. The machine shown in Fig. 15 is very flexible in operation, as the hinges of the aprons may be raised or lowered vertically to suit any class of vessel, and the car and cradle in ascending begin to turn over on striking the hinge point of the apron. This machine has been built with several types of chutes, but the most successful perhaps is the telescopic chute shown, as by its use much trimming of cargo is

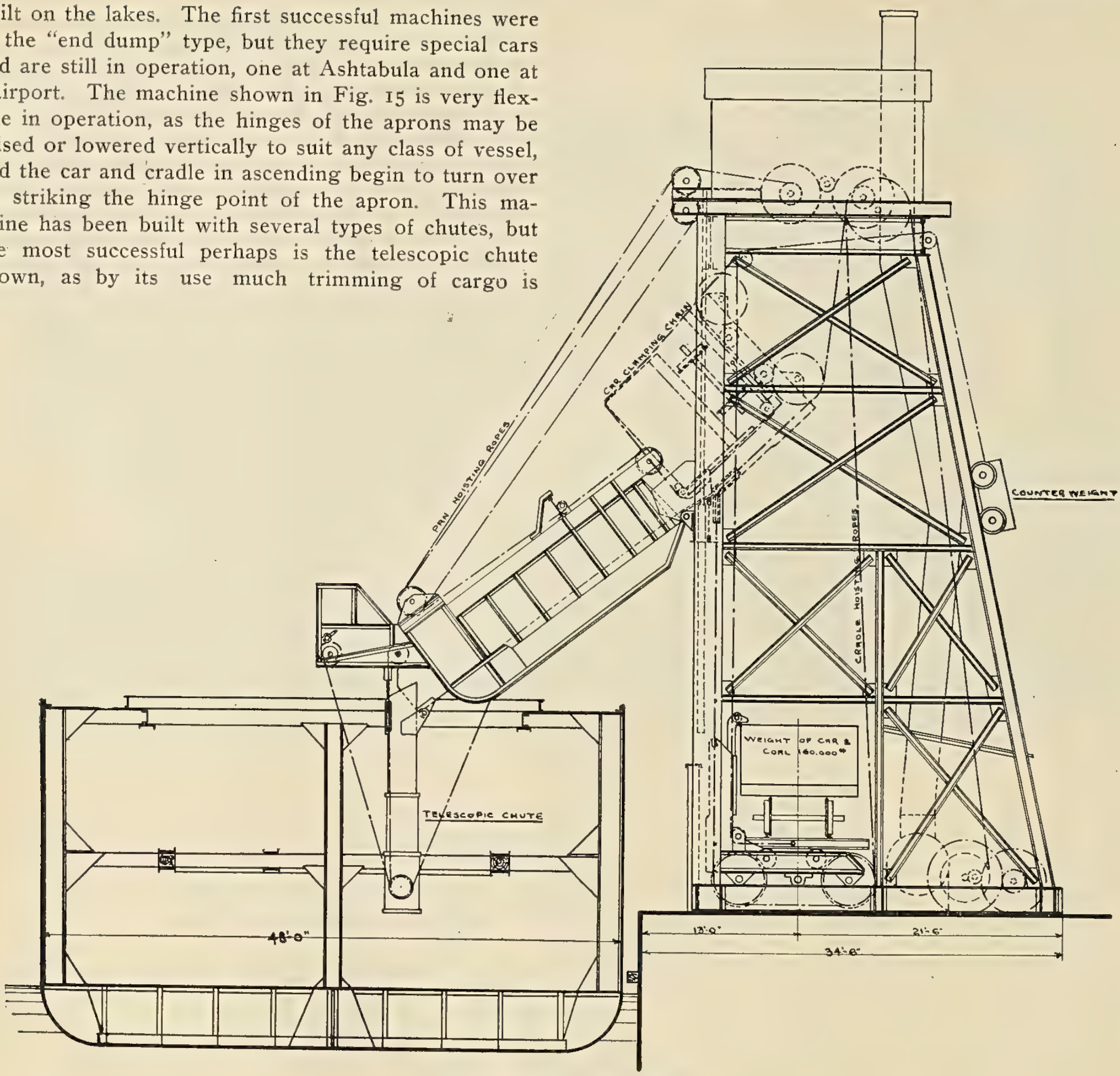


FIG. 15. MCMYLER SIDE DUMP.

avoided. The car clamping mechanism is beautifully simple, being merely four chains with counterweights suspended, the chains wrapping round the car as it is overturned. The cable is hoisted by four 1 1-4 in. cables arranged as a "two part" hoist on 45 in. drums driven through double reduction gearing by a pair of 14 in. by 18 in. engines. The load is lowered by using the engines as air pumps and throttling the exhaust, or with a foot brake, as desired. In operation the machine, though so powerful, is extremely simple, considering the work it accomplishes, and has a record of 32 cars an hour, but of course this speed cannot be maintained on account of delays in switching cars and shifting the boat to reach different hatches. There are three machines of this type in operation. One on the docks of the Cuddy-Mullen Coal Company at Cleveland, one on the docks of the Cleveland Terminal & Valley Ry. at Cleveland, and one at Erie, Pa., on the docks of the Erie and Pittsburg Ry.

Fig. 16 shows the latest type of McMyler car dumper designed to handle the coal more gently in order to reduce the breakage to as small a percentage as possible. There are also three of these machines in operation; one operated by the Pittsburg and Conneaut Dock Company at Conneaut, Ohio, another by The Cleveland, Lorain & Wheeling Ry. at Lorain, and a third at Ashtabula. As will be seen in the engraving, the coal is first dumped into a pan, which is partly overturned to receive it as it rolls out of the car. The pan is then hoisted, the car being lowered meanwhile—until the chute is reached, when a door in the pan opens automatically and discharges the coal into the chute. This machine is also very fast and handles regularly under working conditions 1,000 tons of coal per hour. All the motions with the exception of hauling the cars onto the cradle are performed by a single pair of 16 in. by 18 in. engines. The car and cradle are hoisted by eight 1 1-8 in. cables on 60 in. drums geared to the crank shaft by single reduction gearing. The operations of hoisting and tipping the pan are accomplished by sixteen 1 in. ropes on four drums 40 in. dia. The unit stresses specified by the P. & C. Dock Co.'s specifications covering this machine were as follows:

UNIT STRESSES.

Direct tension machinery steel in structural work, 10,000 $\left(1 + \frac{\text{Min.}}{2 \text{ Max.}}\right)$.

Tension flanges of built girders, 8,000 $\left(1 + \frac{\text{Min.}}{2 \text{ Max.}}\right)$.

Tension flanges of symmetrical rolled sections, 10,000 $\left(1 + \frac{\text{Min.}}{2 \text{ Max.}}\right)$.

Direct compres'n, $\left(10{,}000 - 30\frac{l}{r}\right)\left(1 + \frac{\text{Min.}}{2 \text{ Max.}}\right)$.

Maximum limiting value for direct compression, $\frac{l}{r} = 120$.

l = length of member in inches.

r = least radius of gyration in inches.

Unstayed length of flanges for built beams, $\frac{l}{w} = 16$.

Unstayed length of flanges for rolled beams, $\frac{l}{w} = 20$.

l = length of unstayed flange in inches.

w = width of flange in inches.

MACHINERY SPECIFICATIONS.

Babbitted Bearing Pressures—

For steady pressures, pressure per square inch $\times$ velocity of journal in feet per minute must not exceed 60,000.

For intermittent pressures use 120,000.

For slow-moving bearings (not over 100 ft. per minute) use 600 lbs. per square inch.

Chain and Rope Sheaves and Drums—

For link chains: $\frac{\text{Dia. of sheave}}{\text{Dia. of chain}}$ not less than 18.

$\frac{\text{Dia. of drum}}{\text{Dia. of chain}}$ not less than 24.

Ropes: $\frac{\text{Dia. of rope}}{\text{Dia. of sheave}}$ not greater than 1-30.

$\frac{\text{Dia. of rope}}{\text{Dia. of drum}}$ not greater than 1-45.

For all sheaves: $\frac{\text{Dia. of pin}}{\text{Dia. of sheave}}$ not greater than 1-7.

(To be Continued.)

Seventy war ships are under construction or have their designs in preparation for the United States Navy. Of this number there are twelve battleships, six armored cruisers, nine protected cruisers, four monitors, one gunboat, sixteen torpedo boat destroyers, fifteen torpedo boats, and seven submarine boats. Including with these the ships already in commission or ready for use, the fleet of the United States will consist of the following: Battleships, 18; armored cruisers, 8; cruisers, 16; monitors, 9; gunboats, 26; torpedo boats, 51; submarine boats, 7; special service, 25. The above numbers include the small Spanish gunboats and a fair representation of those converted from yachts during the recent war with Spain. The list of boats for special service includes a certain number of cruisers refitted from merchant steamers; also colliers, distilling, supply and hospital ships, dispatch boats, etc.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—IV.

BY ROBERT H. THURSTON.

THE IDEAL CASES OF THE STARBOARD ENGINES

From the H. P. cards for the starboard engine, the average cut-off was found to be 47 per cent.

Carnot Cycle:

$p_1 = 150.8\#$ p. sq. in. $= 21{,}700\#$ p. sq. ft.

$p_2 = 5.8\#$ p. sq. in. $= 835\#$ p. sq. ft. (from indicator diagrams.)

$v_1 = 2.95$ cu. ft. per lb. steam.

$v_2 = 2.95\,(21{,}700 \,/\, 835)^{.881} = 2.95 \times 13.32 = 39.3$ cu. ft. per lb.

$T_1 = 819°.6$. $T_2 = 629°.6$. $L_1 = 861.7$ *B. T. U.*

$r = 39.3 \,/\, 295 = 13.32$.

$H_1 = 778\,(1191.2 - 95.3) = 853{,}000$ ft. lbs.

Eff. $= (819.6 - 629.6) \,/\, 819.6 = 23.2\%$.

$U = 853{,}000 \times .232 = 198{,}000$ ft. lbs.

$A = 2{,}545 \,/\, .232 = 10{,}970$ *B. T. U.* per *H. P.* per hr.

$C = 1{,}980{,}000 \,/\, 853{,}000 \times .232 = 10.01$ lbs. steam per *H. P.* per hr.

Rankine Jacketed Cycle.

$r = 7.34$ (from indicator and data.)

$p_1 = 21{,}700$. $p_3 = 835$. $v_1 = 2.95$ cu. ft.

$v_2 = 2.95 \times 10.16 = 21.64$ cu. ft.

$p_2 = 2{,}530$. (from steam table). $T_1 = 819°.6$. $T_2 = 666°.1$.

$T_4 = 127.3 + 461 = 588°.3$.

$H_1 = 778\,(1{,}191.2 - 95.3) = 853{,}000$ ft. lbs.

$H_1' = 778\,(666.1 - 588.3) + 1{,}117{,}850\,(1 + \log_e 819.6 \,/\, 666.1) - 544.5 \times 819.6 = 60{,}500 + 1{,}349{,}000 - 446{,}000 = 963{,}000$ ft. lbs.

$U = 1{,}117{,}850 \times .207 - 544.5\,(153.5) + 21.64\,(1{,}695) = 231{,}400 - 83.540 + 35{,}800 = 183{,}660$ ft. lbs.

Eff. $= 183{,}660 \,/\, 963{,}500 = 19.04\%$.

$A = 2{,}545 \,/\, .19 = 13{,}360$ *B. T. U.* per *I. H. P.* per hr.

$C = 1{,}980{,}000 \,/\, 853{,}000 \times .19 = 12.20$ lbs. st. p. *I. H. P.* per hr.

$F = 13{,}360 \,/\, 10{,}000 = 1.34$ lbs. fuel per *I. H. P.* per hour.

Cylinder Condensation:

In calculating this internal waste it is assumed that it takes place entirely in the *L. P.* cylinder. Expressed algebraically:

$W = CA\,(T_1 - T_2)\sqrt{t}$, where $C = .000333$, A = sq. ft. and t = seconds.

The values of A were calculated from the dimensions of the engine.

Area cyl. head	=	42.2 sq. ft.
" piston	=	42.1 " "
" cyl. wall	=	59.4 " "
" piston rod	=	4.22 " "
Total	=	147.9 " "

Add 15% for ports $= 147.9 + 22.2 = 170.12$, total. $T_1 = 247.9°$. $T_2 = 168.7°$. $t = 60/252 = .238$.

$W = .00033 \times 170.12 \times 79.2 \times \sqrt{.238} = 2.12$ per stroke.

No. of strokes per hr. $= 126 \times 2 \times 60 = 15{,}120$.

I. H. P. = 4,700.

W per *I. H. P.* per hr. $= 2.12 \times 15{,}120 / 4{,}700 = 6.83$ lbs.

External Waste:

The waste by conduction and radiation is assumed sometimes at from 2.5 per cent to 5 per cent of the total heat supplied. We found this to be too high, considering the radiation from the cylinder wall to be 0.5 *B. T. U.* per sq. ft. per degree difference of temperature between the cylinder and the engine-room, and that the radiation from the cylinder heads is 2.5 *B. T. U.* This external loss is the same for each engine and was calculated as follows:

Area cylinder heads = 400 sq. ft.
" " sides = 200 " "
Range of temperature = 260 — 100 = 160.
$200 \times 160 \times .5 = 16{,}000.$
$400 \times 160 \times 2.5 = 160{,}000.$
16,000 + 160,000 = 176,000 *B. T. U.* per hour.
176,000 / 4,700 = 37.5 *B. T. U.* p. *I. H. P.* per hr.

Friction Loss:

The friction loss is assumed to be 12.5 per cent in each case.

The remainder of the calculations for this engine are given in the tabular statement at the end of the paper. They are obvious in their derivation.

THE IDEAL CASES OF THE PORT ENGINE.

Carnot Cycle:

$p_1 = 21{,}500. \quad p_2 = 1{,}010. \quad v_1 = 2.98$ cu. ft.
$v_2 = 2.98\,(p_1 / p_2)^{.881} = 2.98 \times 15.12 = 45$ cu. ft.
$r = 15.12.$
$T_1 = 818°.7. \quad T_2 = 637°.9.$
$H_1 = 778\,(1{,}191 - 95.3) = 853{,}000$ ft. lbs.
Eff. = 22.15%.
$U = 853{,}000 \times .2215 = 189{,}500$ ft. lbs.
$A = 2{,}545 / .2215 = 11{,}500$ *B.T.U.* per *I.H.P.* per hour.
$C = 1{,}980{,}000 / 853{,}000 \times .2215 = 10.43$ lbs. per *I.H.P.* per hr.

Rankine Jacketed Cycle:

$r = 7.49. \quad v_1 = 2.98$ cu. ft. $\quad v_2 = 22.3$ cu. ft.
$p_1 = 21{,}500. \quad p_3 = 1{,}010. \quad p_2 = 2{,}520.$
$T_1 = 818°.7. \quad T_3 = 681°.9, \quad T_4 = 588.3.$
$H_1 = 853{,}000$ ft. lbs.
$H_1' = 778 \times 93.6 + 1{,}117{,}850 \times 1.182 - 544.5 \times 818.7 = 948{,}000$ ft. lbs.
$U = 1{,}117{,}850 \times .182 - 544.5 \times 136.8 + 22.3 \times 1{,}510 = 163{,}300$ ft. lbs,
Eff. = 163,300 / 948,000 = 17.2%.
$A = 2{,}545 / .17.2 = 14{,}800$ *B.T.U.* per *I.H.P.* per hr.
$C = 1{,}980{,}000 / 853{,}000 \times .172 = 13.5$ lbs. st. per *I.H.P.* per. hr.
$F = 1.48$ lbs. fuel per *I.H.P.* per hr.

Cylinder Condensation:

$A = 170.12. \quad T_1 = 247°. \quad T_2 = 176°. \quad t = .238$ sec.
$W = .00033 \times 170 \times (247 - 176 \times \sqrt{.238} = 1.95$ lbs. per stroke W per *I.H.P.* per hr. $= 1.95 \times 15{,}120 / 4{,}470 = 6.64$ lbs.

External Waste:

= 176,000 / 4,470 = 39.4 *B.T.U.* per *I.H.P.* per hr.

Actual Water Rate:

Lbs. of coal burned per hour, both engines, = 20,272.
" " water evp. " " " " = 182,448.
I.H.P. of all machinery (including auxiliaries) = 9,300.
" " two engines = 9,170.

Water per *I.H.P.* per hr. (engines) $= \frac{182{,}44}{9{,}170} \times \frac{9{,}170}{9{,}300} =$ 19.6 lbs.

Diagram Water Rate:

The water-rate at cut-off, per diagram, was computed as follows: Starboard Engine—

Equivalent *M.E.P.* for *H.P.* cylinder,
$= 55.24 + (20.7 \times 57^2/35.5^2) + 16.9 \times 88^2/35.5^2.$
$= 55.24 + 53.3 + 104 = 212.5.$
Abs. press. at cut-off = 126.
Abs. press. at end of compression = 100.
Diagram water rate = 14.6 lbs.

Port Engine—
Equivalent *M.E.P.* for *H.P.* cylinder
$= 49.6 + 21.5 \times 57^2/35.5^2 + 16.8 \times 88^2/35.5^2.$
$= 49.6 + 55.6 + 103.8 = 212.$
Abs. press. at cut-off = 127.
" " " end of compression = 110.
Diagram water-rate = 14.7.

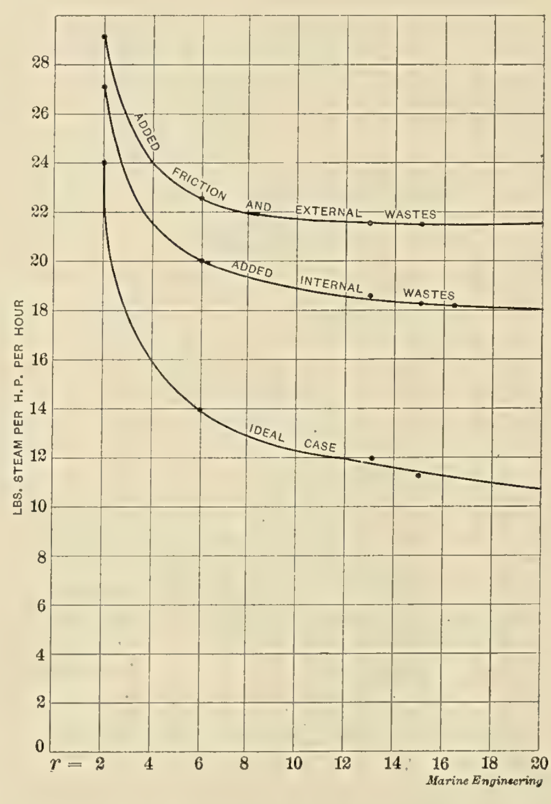
Following will be found the tabulated results:

The curves given show the variation of water-rate with increasing ratios of expansion, for the ideal case, and the added amounts for internal and external wastes.[6]

TABLE V.

U. S. S. MAINE.

	Ideal.		Real.	
	Star.	Port.	Star.	Port.
Lbs. steam p. *I. H. P.* p. hr.	12.20	13.5	19.6	19.6
B. T. U. p. *I. H. P.* p. hr.	13,360	14,800	21,420	21,420
Condensation, st. p. *I. H. P.* p. hr.			6.83	6.64
" *B. T. U.* p *I. H. P.* p. hr.			8,540	8,000
" % energy supplied	35.	32.	34 8	32.5
Thermodynamic efficiency	19 04	17.2		
Efficiency, Carnot cycle	23.2	22 15		
B. T. U. p. *I. H. P.* p hr. (Carnot)	10,970	11,500		
Fuel p. *I. H. P.* p. hr.	1.34	1.48	2.18	2.18
Exterior radiating surface			600	600
Exter. waste *B. T. U.* p. *I. H. P.* p. hr.			37 5	37 5
Lbs. steam p. *D. H. P.* p. hr.	13.93	15.4	22 4	22.4
B. T. U. " "	15,280	16,910	28,000	28,000
Condensation, st. p. *D. H. P.* p. hr.			7.7	7 32
" *B. T. U.* p. *D. H. P.* p. hr.			9,620	9,030
Lbs., st. p. *I. H. P.* p. hr. (pist. displace.)			10.44	10 97
" " " " " (from diagram)			14 6	14 2



[6]The results of this investigation give, of course, only two points on each of the upper curves, but the lower ideal curve was determined accurately by computing the water-rates of several additional cycles working under the same conditions as regards initial and final pressures, but with varying ratios of expansion.

The outcome of this study of a typical and famous case of design of machinery for a war-vessel, is interesting in several particulars, as well as from the fact that it illustrates well the methods of utilization of the modern theory of the real, as distinguished from the ideal, steam-engine. The steam-pressure is what would to-day be termed moderate for a triple-expansion engine in ordinary service; the ratios of cylinders are adapted to a moderate ratio of expansion, a total of about 7:5 and the whole installation is obviously designed to give great concentration of power rather than extreme economy; effecting this purpose by high mean effective pressures and by high engine speed, as well as by extremely careful and skilful design of details, combining in remarkable degree lightness and all needed strength. These favorable conditions and the large size of the engines, aggregating over 9,000 *I. H. P.*, account for the good results noted, in spite of the low ratio of expansion, the moderate vacuum, and the hard-driven furnaces.

Comparing results of trial with those of computation, we find that, could the engines have been converted into the Carnot type, and all extra-thermodynamic wastes extinguished, they would have demanded 10,970 *B. T. U.* per *H. P.* per hour, and 10 lb. of feed-water or steam. Working in a purely thermodynamic cycle of the Rankine adiabatic form, these figures would become at the actual ratio of expansion about 14,000 and 13.4; while the coal demanded would have been, on the assumption above indicated, 1.4 lb. per *I. H. P.* per hour, where, actually, above two lb. were burned, making the extra thermodynamic wastes about fifty per cent.

The computed internal wastes are seen to be about 6 3-4 lb. per *I. H. P.*, raising the computed expenditure of steam to 19 lb. per *I. H. P.*, where, in the ideal case of Rankine, it was 13 lb. The computed external loss by conduction and radiation was found to be insignificant and is neglected. The final comparison, as best shown in the tabulated statement of results, shows very satisfactory correspondence between the computed and the actual results, so far as comparison is permitted, and the curves in the last diagram permit the extension of the study of this case beyond the limits of its experimental range.

It is seen, for example, that the thermodynamic performance of the engine was such as to justify the conclusion that it would give increasing economy, with increasing ratios of expansion, far beyond the limits set by the controlling demand for concentration of power, as illustrated on the trial of the machine, and, in fact, beyond the limits of our diagram, if financial considerations are not brought into the case. The limits set by its own extra-thermodynamic wastes are evidently far beyond those fixed by the special conditions controlling the design of the machinery of a war-vessel.

This case is but one of many illustrating the fact that the engineer, in attempting to design steam machinery —or any other, in fact—for any stated place and purpose, is compelled to study the ultimate aim and purpose, and to adapt his design to its required work by a system of compromises between all the various claims included in the definition, for that particular case, of the term "efficiency."

PAINTS AND VARNISHES USED FOR THE PRESERVATION OF METALLIC SURFACES—III.*

BY PROF. A. H. SABIN.

A still further step consists in the substitution by the makers of driers of rosin or rosin oil for linseed oil. These are found to combine with the lead and manganese oxides even more readily than linseed oil does, and they cost only from a tenth to a fifth as much. Driers made with rosin and benzine are much less expensive than oil. The temptation is to add them in excessive quantity, and this is not uncommonly done. Such a practice is highly injurious, partly because oil thus diluted makes a thinner and less substantial film, partly because an excessive amount of drier makes the film less durable and partly because it is generally agreed by experts that rosin is an injurious addition to oil.

From a consideration of the foregoing it will appear that, while raw oil is a definite substance, boiled oil is a name applied to a large variety of manufactured products. It is also possible to make boiled oil from fish oil or other cheap oils, and these are not infrequently used to adulterate boiled linseed oil. Heavy mineral oil, such as may be purchased at one-fourth to one-half the price of linseed oil, is also used in this way. These latter practices of systematic adulteration are especially followed by the manufacturers of paints. They take the ground that the users of paint ought to pay a fair and legitimate price for linseed oil paints, and that if they prefer to purchase at a lower price it is the business of the paint manufacturer to make, at a reasonable profit, a paint which meets their requirements. It requires a tedious and expensive chemical analysis to detect these adulterations in mixed paint, and those who try to economize by buying paint below its market value are not likely to resort to such means.

The oil, variously compounded or mixed with these driers and solvents, is mixed with the finely-powdered pigment in a mixer, which is usually a cylindrical vessel provided with a revolving stirrer. The pigment has previously been ground dry to such a degree of fineness that most of it will pass through a sieve having a mesh of 100 to 200 to the linear inch. Usually it is not actually bolted, but that is about the degree of fineness which is desirable. The sharper and harder substances should be the more finely powdered. It is common to put the paint thus mixed on the market in this condition as it comes from the mixer, but the more approved practice is to take it from the mixer to a burr-stone mill and to grind the paint through the mill, thus securing a more intimate mixture and breaking up all little lumps. This grinding adds materially to the cost of the paint, and it is probably not commonly done with cheap paints intended for structural metal, since it is impracticable for an expert to take a well-mixed sample of paint and to declare, under oath, that it has not been ground.

What is meant commercially by a pure raw oil paint is made by mixing or grinding a pigment in pure raw linseed oil to which has been added enough drier to make it dry hard enough to handle in twenty-four hours, and containing enough turpentine to amount to from 5 to

* From a paper read before the Boston Society of Civil Engineers, and contained in the Journal of the Association of Engineering Societies, U. S. A.

15 per cent. of the oil. This turpentine is added in order to make the paint work more freely under the brush, and also because it is the belief of the paintmaker that it is impracticable to otherwise add as much pigment to the given amount of oil as is necessary for the greatest durability of the product. It is by diluting the oil and lessening its amount in the film that turpentine acts as a drier. It does not itself promote to any great degree the oxidation of the oil, but by lessening the amount of oil it correspondingly lessens the need of metallic oxide driers. Turpentine is added for technical purposes, not for economy, and it is often more expensive than oil. On the other hand, the use of benzine is always dictated by a desire to save money. In other respects it is objectionable. Kerosene has also been very widely used as a substitute for turpentine, but does not enter into any first-class products.

Varnishes.—Linseed oil is also used in the manufacture of varnishes, which are used as protective coatings, either alone or mixed with pigments. The other ingredients of varnishes are various resins, which give hardness and luster, and turpentine, which again acts as a solvent and is not in any considerable degree a part of the final permanent film, though it does oxidize somewhat, and doubtless a small part of it remains behind while the major portion evaporates.

The varnish resins are of vegetable origin, having exuded, as spruce gum does, from the trunks of trees; and in some few cases these lumps of resin are detached from the living tree and sold for use. Such are called "recent" resins, and the most common one is what is called "manila," and comes from the East Indies. More often the resins are not suitable for the varnishmaker until they have acquired considerable age. The tree to which the lumps of resin are attached died and fell to the ground and decayed; the resin became gradually buried in the earth; its volatile part escaped; it became hard and brittle. In this state it is found by the natives, who dig it up and sell it to the local trader, and it becomes an article of merchandise. Such are called "fossil resins;" they are of many sorts, and are found at many places, especially in the tropics. Africa, South America and especially New Zealand are great sources of supply.

The varnish resins are commercially spoken of as gums, but differ from true gums, such as gum arabic, in being insoluble in water. These pieces of resin are carefully cleaned, by scraping and otherwise, and sorted; the paler sorts are more valuable than the darker; not because they are otherwise better, but because they are less common, and people value pale varnishes more than equally good dark ones. The varnish-maker puts a quantity of this resin, usually 100 pounds, in a flat-bottomed copper kettle capable of holding about 150 gallons, which is mounted on a little iron truck, and this kettle is placed over a hot coke fire. In about half an hour the resin has melted, the temperature being from 600° to 900° F., and is found to have lost from 20 to 25 per cent. of its weight, which has gone off as a vapor. In reality, the resin has become decomposed by the intense heat, and what remains in the kettle is one of the products of this decomposition. Immediately the varnish-maker takes the kettle from the fire and adds to it some hot linseed oil, the quantity varying from about 30 pounds to sometimes as much as 300 pounds. The oil having been slowly added and well stirred in, the kettle is returned to the fire, and its contents are cooked together until combination is effected.

If it is desired to produce a hard varnish, with a very brilliant surface, a comparatively small amount of oil is used; but if the varnish is to be highly elastic and durable a large proportion of oil is necessary. Since one of the most essential qualities of a varnish for any ordinary use is a high degree of luster, while durability is of less account, because most varnishes wear off by use of the articles to which they are attached, it will be plain that for the preservation of structural metal work against corrosion an entirely different kind of varnish from those in ordinary use is required.

When the resinous matter and the oil are properly combined, which may take many hours, the kettle is removed from the fire and allowed to cool somewhat, and the contents are then diluted by the addition of an amount, previously found to be suitable, of spirit of turpentine, so that when cold the varnish will flow properly under the brush. Varnish is much more viscid than oil, and it is therefore possible to apply it in a thicker film. It is much harder than oil, and therefore resists abrasion; and it is much less porous than oil. It therefore naturally has by itself in some degree the qualities which we aim to give to oil by the introduction of pigments; and if it be so made and proportioned that it does not contain in itself the elements of dissociation, there can be no question that is is more valuable than an oil paint. As a matter of fact, it has for generations been used over paint to protect it from the weather, and no fact is better established than the permanence of a well-made varnish.

The question naturally arises, why may we not still further increase this permanence, as we do in the case of an oil film, by the addition of a pigment? If the latter works so well with oil, why may it not with varnish? The fact is that pigments do increase the durability of varnishes for the same reasons and in the same degree that they benefit oil films, and by far the most permanent paints which it is possible to make are made in this way. These will not, of course, be as brilliant and lustrous as the varnishes alone, the pigment having an opposite effect, but will be far more so than an oil paint, and will be smoother and harder; while if properly made, they will remain sufficiently elastic.

Varnishes are sometimes observed to crack and to come off bodily, instead of wearing off from the surface. This is the worst fault a varnish can have, and is due to its being made of unsuitable materials or in an unskillful way. Any considerable amount of common rosin in a varnish will cause this, and it may also be due to other causes. A good varnish, used for the purpose for which it was designed, will not do it. The commonest adulterant of varnish is rosin, which may itself be made into a varnish and mixed in any proportion. A well-made rosin varnish has a very brilliant surface, and works fairly well under the brush, but a comparatively small amount of rosin will simply destroy the durability of the best varnish.

The objection to the use of varnish paints is their cost. From the nature of things, varnish is much more expensive than oil. When one puts so valuable a material as a good varnish into a paint he naturally will

insist on putting it through a mill, and when we compare the cost of it with that of an oil paint run through a mixer there will be a striking difference. Suppose it costs twice as much. This would probably be a minimum. The minimum cost of applying any paint will be as much as the price of the oil paint. Then, when the two are applied, they have cost in the proportion of two to three. If the varnish paint will last fifty per cent. longer than the oil paint, it will then be as economical. It is the opinion of the writer that it has been proved by actual use to be more than 100, and in many cases 300, per cent. more lasting.

Varnishes are also made which contain asphaltum, which is a mineral resin, instead of the vegetable resins already described. These are, of course, black, and they may be made with part vegetable resins and part asphaltum if so desired. The objection to asphaltum is that when used with any considerable proportion of linseed oil its remarkable non-drying qualities make it difficult of use. Its advantage is its cheapness and also its wonderful permanence. When properly combined, however, it is a most valuable material. The simplest way to overcome its effect of preventing the oxidation of oil is to subject the varnished object to the action of hot air. The activity of the oxygen is thus enormously increased, and oxidation proceeds in spite of all obstacles. This is the process known as japanning or enameling, and it has the further advantage that the adhesion of the coating to the metal is much increased, while at the same time the porosity of the coating is reduced almost to nothing. This is because the coating material is kept in a melted or semi-fluid condition while the oxidation is going on, and the pores are destroyed or closed by the flowing of the material itself.

The way this is done is by coating the object, usually by dipping it in the varnish. Then it is put in an oven and baked at a temperature of from 200° to 400° F. for several hours. Sometimes several coats are thus applied in succession. Varnish paints are sometimes applied in this way, making colored enamels of great beauty and durability. But it is possible to use asphaltum in varnishes which will dry at ordinary temperatures. This is most commonly done by using very little oil; also by a large amount of drier, but better by mixing a varnish of asphaltum with one made of other resins. It is also possible to make a varnish containing a considerable amount of asphaltum which will dry reasonably well by great care and skill in its fabrication. It may safely be said that asphaltum is one of the most difficult substances to use, that while excellent results are obtainable, they are more difficult to obtain than with any other substance, and that bad results are very common.

In conclusion, it remains to be observed that while nothing is here said of the importance of methods to be employed in cleaning the metallic surface, this is not because it is a matter of minor importance. On the contrary, it is of so great importance that a separate discussion of its value and the means of doing it would be necessary, and this paper is therefore confined to an account of the materials used. The comparative value of these is difficult to determine, and varies in different cases; but in general the writer has been led to the conclusion that there is not a very decided difference between different pigments in their value for the prevention of corrosion; that varnishes and varnish paints, when made with proper knowledge and skill, are better than oil paints; that these latter give probably better average results than red lead, but that, when the best possible results of red lead are attained, it is considerably better for most exposures than oil paints, and that the use of adulterated materials, either through ignorance or design, is a most serious and common evil. This is rather the fault of the purchaser than of the maker. If the former would not buy, the latter would not make the inferior article.

STEEL FREIGHTERS PLEIADES AND HYADES, FOR THE BOSTON TOWBOAT COMPANY.

Among the vessels recently turned out at the Atlantic coast yards, none possesses more interest, for those who hope for the return of the supremacy of the American merchant marine, than the two steel steamers for the Boston Towboat Company, built at the Sparrow's Point yard of the Maryland Steel Company. These vessels, the S. S. *Pleiades* and the S. S. *Hyades*, are of a type on which will depend largely the future of the American merchant marine—the ocean freighter. This type of vessel, unfortunately, has not been hitherto of frequent occurrence in the American registry. The new vessels are distinctively cargo-carriers, and are similar to the better class of "tramp" steamers now so numerous under flags other than our own. They are designed to carry freight in bulk, such as coal, grain, rails, etc.

The dimensions of the vessels are: Length over all, 350 ft.; length between perpendiculars, 330 ft. 6 in.; beam moulded, 47 ft.; depth at side moulded, 28 ft.; sheer forward, 8 ft.; aft, 3 ft. The gross tonnage is approximately 4,000 tons.

As they are from the same designs, the description of one will apply to both.

Steel castings have been used to a considerable extent in the construction, the lower part of the stem, the stern frame, rudder frame, and extension stock being of this material. The upper part of the stem is a steel forging.

The hull is built to the highest requirements of the United States Standard Register of Shipping for twenty years rating. There are seven full bulkheads extending the entire width of the ship, six of them water-tight, and extending to the upper deck. There are two steel decks extending all fore and aft, 1-2 in. thick; a poop deck 50 ft. long, a bridge deck 80 ft. long, and a forecastle deck 50 ft. long, all of steel, 3-8 in. thick.

The water bottom is 40 in. deep, and extends from the collision bulkhead forward, to the stern tube bulkhead aft, affording capacity for a water ballast of 750 tons, in addition to 353 tons in the forward and after peak tanks.

The tanks are operated by means of a horizontal duplex ballast pump having steam cylinders 7 1-2 in. dia., and water cylinders 10 1-4 in. dia. by 10 in. stroke.

The sea valves are arranged so that the tanks are filled through the pipes by which the ballast pump empties them. These pipes are 5 in. dia., and as the tanks extend clear across the ship provision has been made for drawing the water from either side of the tanks, so that the

vessel may be pumped out completely, even when listed far to one side.

The engine room tank does not extend across the ship, the centre keelson being water-tight in this compartment, pipes leading from the ballast pump to each of the two tanks. The after frame space under the engine room is made water-tight, and used to receive its drainage, one of the main bilge pumps being used to free this tank of water.

The vessel has seven cargo hatches, the largest 20 ft. square, and the smallest, 20 ft. by 14 ft. On the lower deck they are increased to 26 ft. in width. The covers for the upper deck hatches are of steel, and for the lower deck hatches, of wood. On the lower deck numerous plates have been made portable to assist in trimming coal.

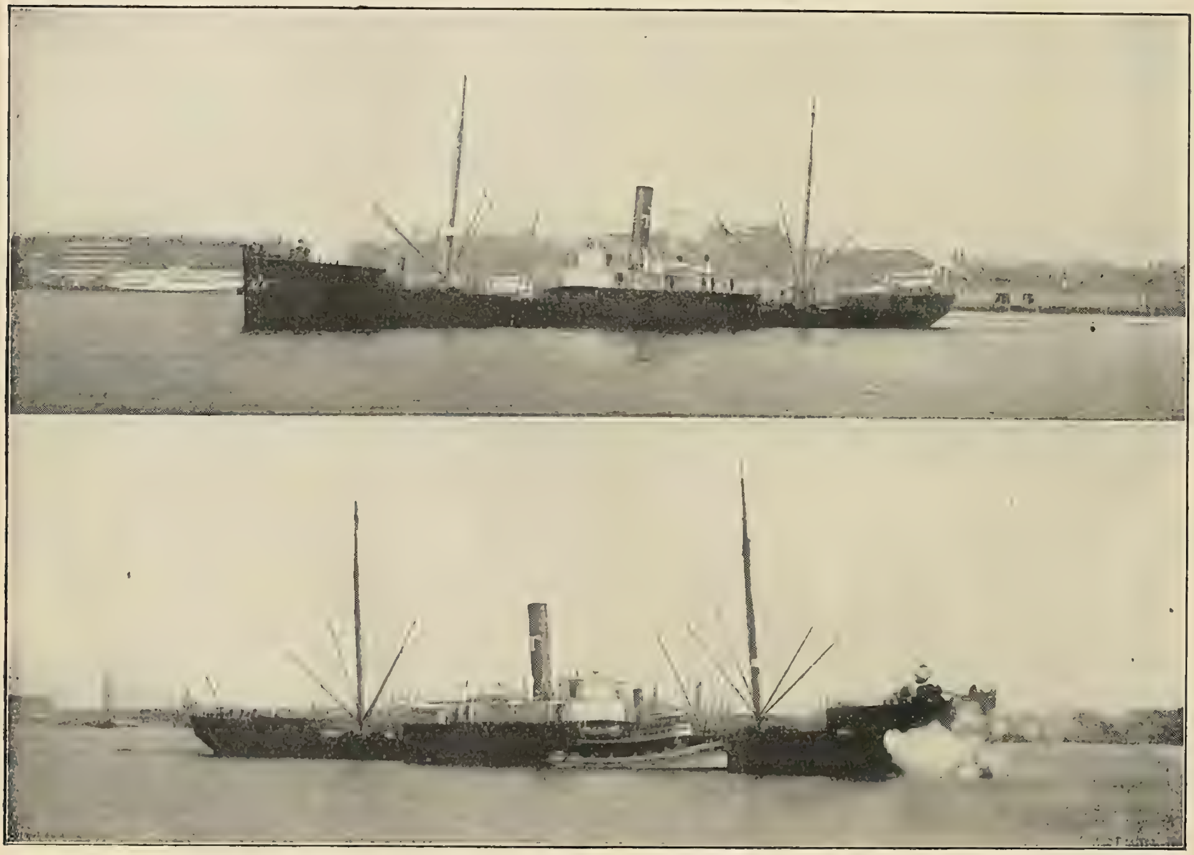
The ship has a complete outfit of deck machinery of the latest type. The windlass is for 2 1-8 in. chain, and was manufactured by the Hyde Windlass Co. The four deck hoisters are Williamson's double drum, double cylinder, 8 in. by 8 in., spur geared type. The capstan aft is a No. 3 Hyde, with cylinders 6 in. by 8 in.

The steering engine, 7 by 7 Williamson, is located in the after end of the engine room on the main deck, the steering ropes leading along on top of the upper deck to the quadrant, under the poop deck. A Robinson No. 9 hand steerer, made by the Bath Iron Works is connected to the extension stock on the poop deck.

There are two 20 ft. metallic life-boats, carried on bridges alongside the house, and an 18 ft. dinghy stands on the bridge deck.

The masts are of steel, with wooden topmasts, rigged as a fore and aft schooner, with leg-of-mutton sails. Each mast has four cargo booms, stepped in cast steel sockets, riveted to the masts. In addition to these are two booms, stepped in sockets on the main deck, between the second and third hatches.

The quarters for officers are arranged in a house on the bridge deck. The Captain has a large room on the starboard side, with a private bath, and ample saloon. The galley extends across the house, between the boiler casing and engine skylight. On the starboard side are officers' staterooms and engineers' state and messrooms; on the port side the Captain's pantry, officers' mess-room and toilet, and two spare rooms.

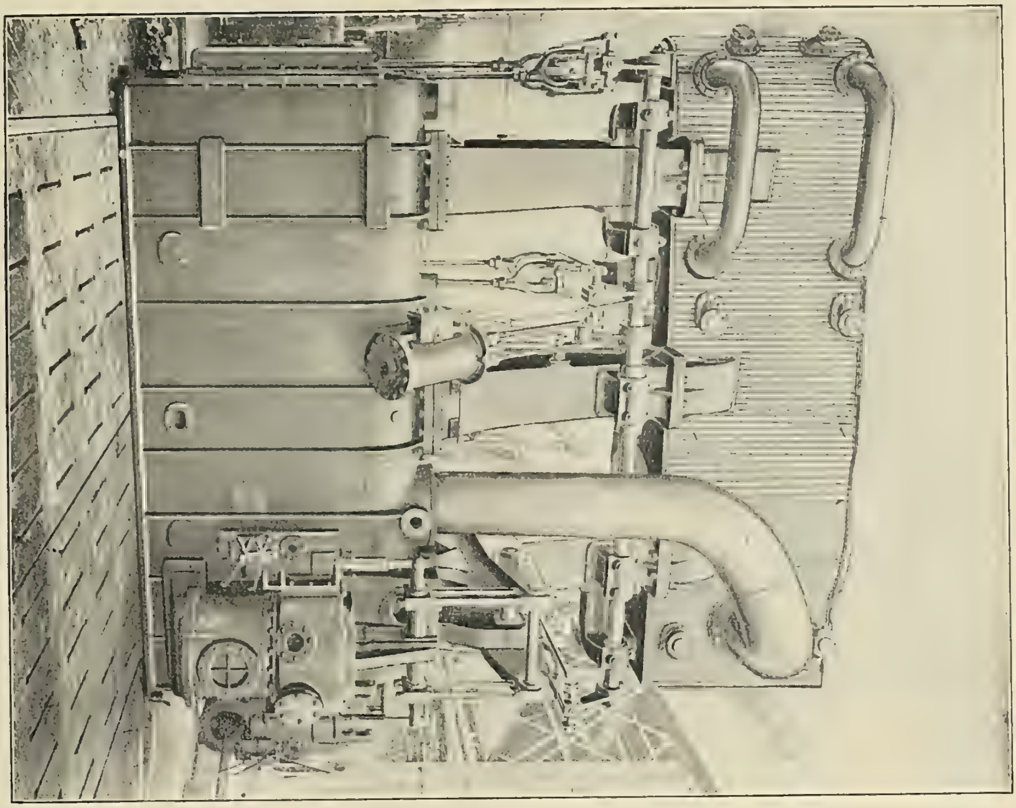


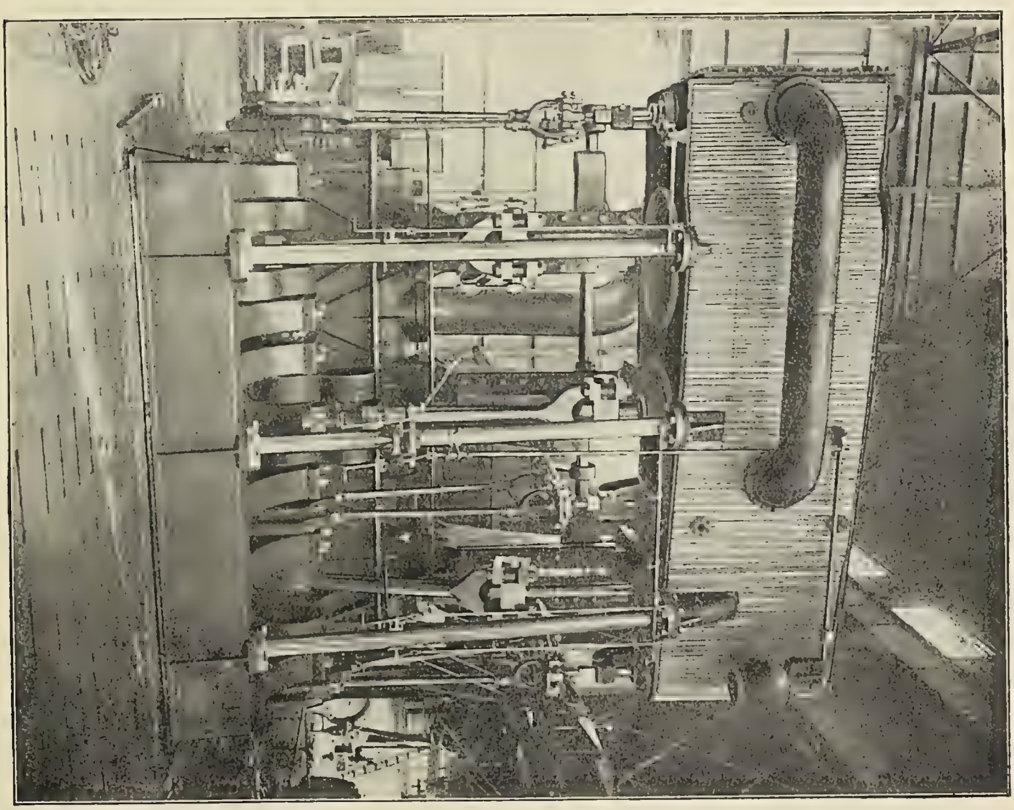
VIEWS OF THE BOSTON TOWBOAT COMPANY'S STEEL FREIGHTER HYADES.

The deck house is surmounted by a steel pilot house and chart room, with a private stairway from the Captain's room. A bridge is carried from the side of the house to the side of the ship, with a flying bridge directly above.

The crew's quarters are under the forecastle deck. The entire crew, including officers, will number about thirty.

The engine cylinders are 21 in., 35 in. and 56 in. dia. respectively, by 42 in. stroke, arranged with the H. P. forward, and the L. P. aft. The horse power is about 1,600 on 90 revolutions per minute. The H. P. and I. P. cylinders are fitted with piston valves, and the L. P. cylinder with a double ported slide valve, and a counter balance cylinder for taking the weight of the valve off the valve gear. The latter is of the ordinary Stephenson





FRONT AND BACK VIEWS OF THE MAIN ENGINE OF THE STEEL FREIGHTER HYADES.

type, with double bar forged links. The H. P. cylinder is fitted with a cast iron liner, which is held in place by gun metal tap bolts.

The crank shaft is of the built-up type, 12 in. dia. in the journals and pins, of forged mild steel throughout. The connecting rods, piston rods and crossheads are of forged steel.

The excellence of the steel castings available at the present day has made it possible to use this material for certain parts of the engine, and thus avoid some of the expensive forgings formerly necessary; among these being the forked ends of the eccentric rods, and the reversing arms.

As shown in the cuts, the engine is of the open front type, having steel front columns and slipper slides on the crossheads, working in guides bolted on the back columns, the latter being built on top of the condenser.

The condenser contains 2,587 sq. ft. of cooling surface, the tubes being 3-4 in. outside dia. and 15 ft. long, of brass. The reversing engine is placed on top of the condenser, where it is easily accessible for overhauling, and works to good advantage. It is 12 in. dia. by 20 in. stroke, and is supplied with steam at boiler pressure.

The air pump is bolted to the back of the condenser, and worked off the low pressure crosshead. It is 24 in. dia. by 13 in. stroke, and has one bilge pump on its forward side, and one on the after side.

The main exhaust pipe is of copper, 19 in. dia. The main steam pipe is of copper, 8 in. dia., and leads to a cast iron throttle valve, of the ordinary double beat type, with compound lever connections. The handling gear for the throttle valve and reverse engine is attached to the middle front column, and worked from the lower platform. The cylinder drain cocks are worked by levers under their respective cylinders. The by pass valves are worked by rods leading to them from the lower platform fitted with hand wheels, directly over the throttle and reverse gears.

A worm and worm wheel are fitted at the after end of the engine for turning it over by hand when setting valves, or making repairs.

The thrust block is set up on a continuation of the steel foundation under the engine, but is not bolted directly to the engine bed plate. It affords a bearing surface of about 685 sq. in., which reduces the pressure due to the thrust of the propeller to about 45 lb. per sq. in. The main engine and the thrust and line bearings are fitted for ample water circulation. The thrust shaft is 12 in. dia., and has six collars, 19 in. dia. The line shafting is 11 3-4 in. dia., and the propeller shaft is 12 1-4 in. dia., all of forged steel.

The propeller wheel is of the sectional type of cast iron, with four blades, 14 ft. 9 in. dia., by 13 ft. 9 in. pitch at the tips, and 13 ft. 3 in. at the root of the blades. The developed surface is about 75 sq. ft.

The two Scotch boilers fitted are 14 ft. 6 in. dia., by 10 ft. 9 in. long, inside of the heads, and are built for 175 lb. steam pressure. Each boiler contains three corrugated furnaces of the Purves type 45 in. dia., 19-32 in. thick. The tubes are 3 1-4 in. dia. by 7 ft. 7 in. long. The total heating surface for the two boilers is 4,400 sq. ft., and the grate surface 146 sq. ft., making a ratio of heating surface to grate surface of 30.

Each furnace has a separate combustion chamber, the backs of which are slightly inclined to give as free liberating surface as possible for the steam.

The axes of the boilers are placed fore and aft, and the fire room is 10 ft. wide in that direction.

The smokestack is high, its top being 71 ft. above the grates, which, however, is not excessive for natural draft installations.

The coal bunkers are forward, and at the sides of the fire room, with a capacity for 625 tons of coal, which is sufficient for a transatlantic voyage.

The athwartship bunker is recessed in the middle of its length for an ash ejector hopper, which sends the ashes overboard on the starboard side. One of the two 30 in. ventilators in the fire room is arranged to be used as a passage-way for ash buckets in case the ash ejector is being overhauled, and a steam hoister is bolted to the forward bulkhead of the fire room for the purpose of handling the buckets.

An electric lighting plant, furnished by the B. F. Sturtevant Co., consisting of a 10 K. W. generator and an upright 7 in. by 7 in. engine, supplies current to 80 incandescent lights and to a 3,000 C. P. searchlight.

These steamers are intended to make 10 knots speed, when loaded to 22 ft. draft, at which draft they will carry 5,500 gross tons dead weight. The immersed midship section area is 1,010 sq. ft. at the above draft, the wetted surface 24,600 sq. ft., and the tons per inch immersion, 33 1-2. The cargo capacity, including bridge house and poop, is 259,600 cu. ft., or 5,750 tons, at 45 cu. ft. per ton. The vessels are fitted with tanks holding 6,000 gals. of fresh water.

The design and construction of the two boats has been conducted under the personal supervision of C. W. Wiley, superintending engineer for the Boston Towboat Company.

Loss of S. S. Mexican.—Probably the most serious disaster in connection with the transport service between the mother country and the seat of war in South Africa, was the loss of the Union-Castle liner *Mexican*, which was run down by the transport *Winkfield*, but fortunately remained afloat long enough to effect a transfer of passengers from the liner to the transport. The *Mexican* left Cape Town on a homeward trip April 4, and soon after ran into a fog bank. She was slowed to half speed, and when about 80 miles out she was rammed amidships by the *Winkfield*, bound to Cape Town with troops and horses. The *Winkfield* was badly damaged, but was in no danger of foundering, and to her the 200 odd passengers and crew of the *Mexican* were transferred in the boats, together with most of the mails and valuables. The *Winkfield* then proceeded to Cape Town and reported. Another transport was immediately dispatched to find the *Mexican*, but that vessel had apparently gone down, for no trace of her was to be seen.

Prize Money.—The U. S. Court of Claims has awarded Rear Admiral Sampson $8,375 as his share (one-twentieth) of prize money for the destruction of the Spanish vessels at Santiago. The further sum of $158,365 is to be apportioned among the U. S. naval officers and men of the ships which participated in the battle.

SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

An Account of the Courses and Conditions at Glasgow University, Written by An American Student.

BY GEORGE CROUSE COOK.

The University of Glasgow was founded by authority of Pope Nicholas V in a bull issued during the year 1450-1. This bull also granted the University power to confer such degrees as were then in vogue and established certain laws and regulations. In subsequent years, through the energy and zeal of its leaders, the University won a permanent and growing patronage. Its original three faculties have been gradually increased to five at the present time, viz., Arts, Science, Medicine, Law and Theology, engaging the services of thirty-one professors.

The character of that portion of Glasgow in which the University was established at its foundation became so changed in the later growth of the city, that early in the present century the question of removal to a more desirable section was discussed. After several unsuccessful attempts had been made to secure a change of location sufficient money was obtained by private subscriptions and State aid, in the year 1864, to purchase a valuable site in the northwestern part of the city, and there erect suitable buildings for the educational necessities of the time. In addition to the new buildings, a three-story portion of the old college, which bears the date of 1658, was taken down, removed to the new site, and there re-erected with slight modifications as a gate-lodge at the northeastern entrance to the University grounds.

Within limitations prescribed by the State, the University is governed by two bodies. The first is the Senatus Academicus, which is composed of the principal and the whole of the professors, and which has charge of the instruction and discipline of the students, the awardment of degrees and which determines the exemption from any part of the University course or examinations of a candidate for a degree who presents certificates from other schools. The second body is the University Court, which is composed of the principal, representatives of the Glasgow City Council, the University faculties, the graduates and students. It forms a court of appeal from the Senatus in certain cases and administers the funds and property of the University.

DISTANT VIEW OF MAIN BUILDING, GLASGOW UNIVERSITY.

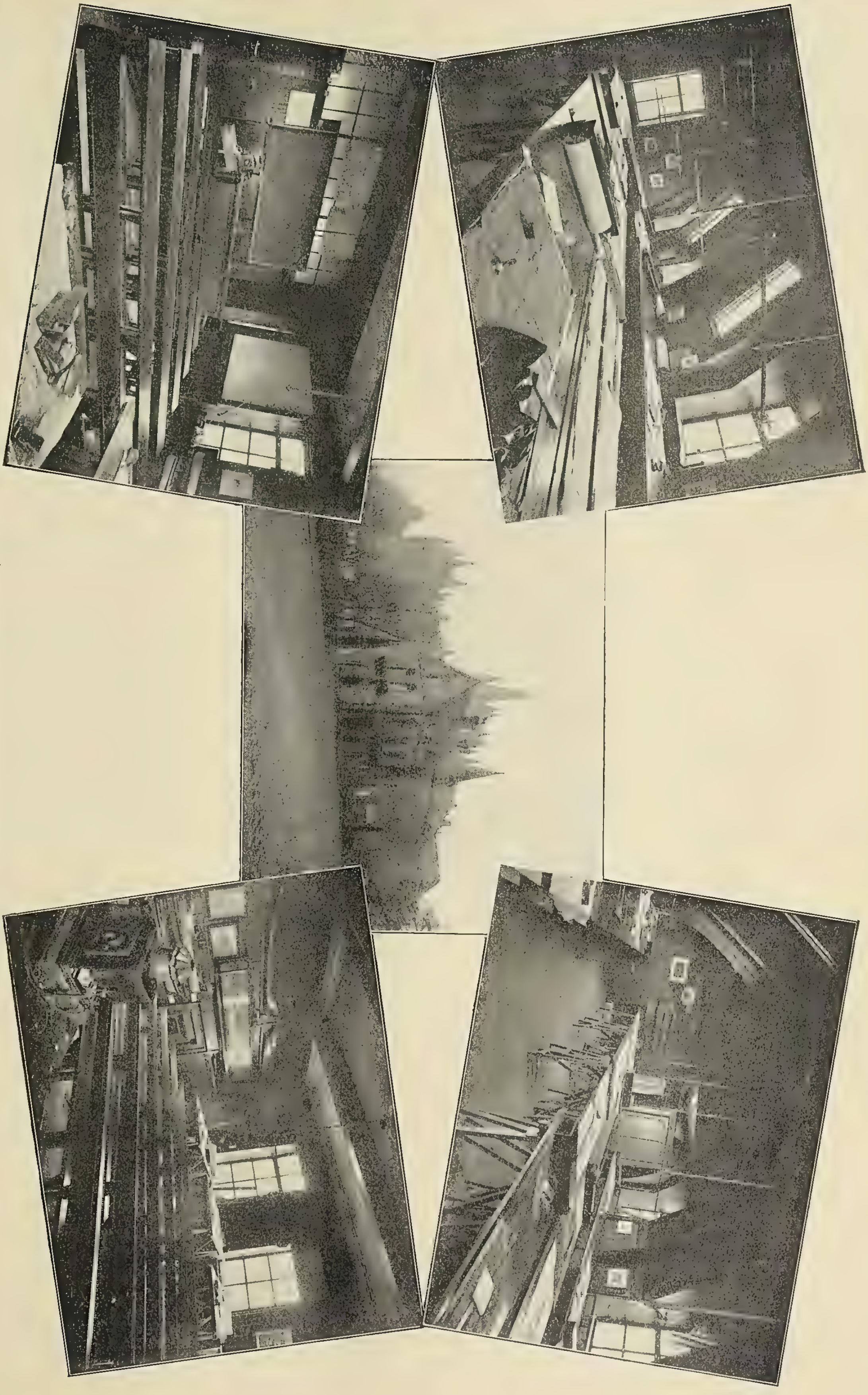
The modern development of the Faculty of Arts was materially advanced when, in 1883, the widow of John

Elder, who was the head of what is now the Fairfield Shipbuilding Co., of Glasgow, endowed the University with the sum of $60,000 for the support of a chair to be known as the John Elder Chair of Naval Architecture. This chair was later connected with the Faculty of Science on its foundation in 1893. As no satisfactory space in the main building was available for this work, the two upper stories of the previously mentioned Gate Lodge were fitted up as drafting, lecture, and professor's rooms. The entire upper floor is used as the drafting room. This is heated by two open fireplaces and lighted by side and overhead windows and gas. Fixed drawing boards, with drawers, are built about three sides of the room, while along the central part stand a number of portable tables. The tables are supplied with battens, weights, three good planimeters, a convenient calculating machine and two excellent integrators. A relic of the racing yacht *Valkyrie*, some working models, and a few framed photographs hang upon the wall and complete the equipment of the room. The second floor, of the same dimensions as the upper, is divided by a bulkhead into a lecture room and professor's office. The lecture room is heated by a single fireplace, and is fitted with raised platform and desk for the lecturer; back of this desk on the division bulkhead is a slate blackboard, while on one side rests a stereopticon for illustrating lectures, with the associated screen on the opposite wall. Half a dozen rows of narrow wooden benches, with narrower desks for the students, are arranged in front of the platform. Apparatus for demonstrations and for the illustration of lectures stands about the room, and models of different types and varying degrees of completeness and condition hang upon the walls.

The course of this chair is designed to be taken as a portion of the regular curriculum leading to the degree of B. Sc., and extends over three sessions. During the first session, in association with other regular work, a junior course in ship and engine drafting is taken, which requires at least nine hours per week attendance in the drawing room; this time is usually made up on three days from 2 until 5 o'clock. In the second session a junior course of lectures in naval architecture and marine engineering is attended, and a senior course in drafting; the senior lectures are given daily, except Saturday, from noon to 1 o'clock, while the drafting is arranged as in the junior course. The third session consists of the senior course of lectures, which are given daily, except Saturdays, from 11 to 12 o'clock. In both junior and senior series of lectures a lecture on an average of once a week is given on the subject of marine engineering.

The junior course in drafting takes up the following work: Laying off and fairing a vessel from offsetts; calculation from these lines, of displacement, centers of buoyancy, areas and centers of gravity of water planes, tons per inch, moment to change trim, transverse and longitudinal metacenter and coefficients of form; drawing sections for cargo space, plotting cargo curves, distribution, and center of gravity of cargo vertically; calculations of curve of metacenters and the metacentric height under various densities of cargo; calculations for change of trim with bilged compartments; curves showing percentage of length, which may be safely flooded; launching calculations, with curves; strength, calculation of distribution of hull weights, curves of supporting forces in various forms of waves considering the various pressures due to depth, curves of load, shearing forces and bending moments; the ship's section at point of maximum stress and calculations of its inertia and effect of the bending moment; distribution of shearing stress at point of maximum shear; drawing sections by various rules and, if the time permits, designing a marine boiler. The senior course of drafting includes: Designing a vessel to fulfill given conditions of speed, weight, carrying power, etc.; general arrangement plans and corresponding structural plans; stability calculations under different conditions and cross curves of stability; calculations upon the results of trial trips. The design taken up by students may be a battleship, cruiser, torpedo boat, cargo or passenger steamer, and sail or steam yacht, and if there be sufficient time the principal parts of a steam engine.

The junior series of lectures embody the following topics: Ship calculations, including displacement, center of buoyancy, metacenter, change of trim, experimental determination of center of gravity of a ship, effect upon trim and stability due to flooding compartments, also due to filling part or whole of holds with cargoes of varying density, lifting and tipping efforts in launching, and tonnage; strength of ships, including general consideration of strength of a girder, application to a ship in still water, elements of trochoidal wave theory and its application to finding supporting forces in a ship on a wave, determination of distribution of weight in a ship and the resultant effect upon her structure when in still and wave water, both in upright and inclined positions; consideration of effect of heave of sea upon supporting forces and weights; transverse strength of ship, strength of various details of construction, including butt fastenings. The senior series comprises: Stability of ships, including the mathematical investigation of the fundamental formulæ of stability calculations, consideration of the surface of buoyancy and flotation, metacenter curves, curves of statical and dynamical stability, cross curves of stability, elementary considerations of oscillation of a ship in still water and among waves; resistance and propulsion of ships, including consideration of the earlier theories and experiments of Froude upon models; relation of resistance of ship and model, law of comparison, progressive trials of ships, relation of effective to indicated horse power, effect of waves upon speed of ship, theoretical efficiency of various kinds of propellers, determination of best diameter of propeller for a ship, ship design, including determination of dimensions of ship to fulfill given conditions, method of determining form of ship, estimates of weight of hull and outfit, weight of machinery in relation to power and type, approximate methods of determining elements of design for preliminary consideration, factors of strength for various types of ships, consideration of points of importance in special classes of vessels. The engineering lectures for Seniors and Juniors cover: Marine Engine and Boiler Design, including determination of sizes of cylinders, valves, shafting, pumps, propellers, boilers, furnaces, funnels, steam pipes, etc., with the theoretical and practical considerations governing marine practice.



GATE LODGE AND INTERIOR OF RECITATION AND LECTURE ROOMS IN NAVAL ARCHITECTURE.

In the drawing room, the instruction is under the immediate direction of the assistant professor, who lays out the work for each student and daily inspects its progress and character, giving such direction and assistance as may be required; the professor makes an occasional visit, criticising and suggesting. The naval architecture lectures are given in the lecture room by the professor, who occupies the platform, and board and lantern are frequently put into use in demonstration and illustration. While there is a definite line which the lectures follow, there are frequent, interesting, impromptu discussions by the professor, which are taken from his store of practical experience. In the occasional absence of the professor, the platform is occupied by his assistant, who also delivers the lectures on Marine Engineering.

The complete course as outlined in the foregoing is, as already stated, the one taken by students entered for the degree B. Sc. and is, of course, the most satisfactory. There are several modifications of this which are taken by men having no interest in the general degree work, or with limited time or means to devote to study. A very satisfactory one of these, and the one taken by a great number of American students, extends over a single session and consists of the Junior and Senior lectures together with the Senior Drafting. It is obvious that a student to get the full benefit of this time must have a good foundation in the elementary principles of naval architecture and a good working knowledge of mathematics including the first principles of the integral calculus. For this special course, no preliminary examinations or qualifications are required, and on completion, all lectures, examinations, and classes having been attended satisfactorily, a certificate is given of proficiency in naval architecture. This session extends from October 20 to March 27, with a vacation of two weeks at Christmas. Holidays can be most satisfactorily employed in visiting neighboring shipyards, where students are generally admitted. A second excellent course which calls for an attendance during two sessions and results in a "Certificate of Proficiency in Engineering Science" consists of the following work: The four classes in naval architecture and one session in each of the following classes: mathematics, including integral and differential calculus, natural philosophy, chemistry and engineering with laboratory practice. This last, under the widely known experimentalist, Dr. A. Barr, deals with the strength and elasticity of materials, or it might be put as the stress and strain on materials in structures and machines, and hydraulics which investigates the principles of the flow of water and its action as a motive power. This course requires no preliminary examination and a student with previous training may be excused from attendance on certain of the classes, but must pass the final examinations at the University. During the intermediate summer vacation, a good draftsman can usually find work in a Clyde shipyard office, where the wages run from $10 to $14 a week, and an inexperienced man could get apprentice work in a yard.

Professor J. Harvard Biles, who now occupies the Chair of Naval Architecture, received his early technical education in the Government Dockyard at Portsmouth, England, and later attended the Royal Naval College at Greenwich, from which he graduated in 1875. He was then appointed an assistant naval constructor in the British Navy, and was assigned to duty at the Pembroke Dockyard, later being ordered to the Admiralty in London. In 1880 he resigned from the naval service to accept a position as naval architect at the well-known Clydebank Yard. Probably the best-known ships turned out during his connection with the yard were the *Paris* and *New York*, now of the American Line. In 1880 Mr. Biles left Clydebank for Southampton, where he acted as general manager for a new yard, and from there he passed to the Glasgow University. In taking up this educational work Professor Biles has not relinquished outside professional practice, but maintains an office as a consulting naval architect, and as such has been connected with the construction of many modern merchant and naval vessels.

Assistant Professor H. C. Sadler is a graduate of Glasgow University, having obtained the degree of B. Sc. in 1893. After leaving college he entered the shipyard of A. and J. Inglis, Glasgow, as a premium apprentice, and upon the expiration of his five-year term was appointed a calculating draftsman for the firm. From this position he was appointed to the assistant professorship in the University. He is an associate of Professor Biles in the latter's outside professional interests.

With many students the question of expense is of considerable importance. The total expense for a person starting with outfit for six months, from New York City, and taking the one session course with three classes already outlined can be brought, barring accidents, within $375. Itemized it will stand as follows: A return passage from New York to Liverpool or even Glasgow itself, on an intermediate class steamship, can be had for $90. The University fees sum at $50, for matriculation or enrolment as a student a fee of $5, and for each of the three classes attended, $15. The cost of necessary books, drawing paper, pencils, etc., is covered by the sum of $10. The expenses of living are practically within control. As there are no accommodations for students at the University, a usual, cheap, and satisfactory manner of living is that of hiring rooms with service and buying such articles of food as may be required. Service here includes care and cleaning of rooms with cooking and serving as purchased or directed. The front room of a clean, wholesome flat, in the neighborhood of the University, occupied by a mechanic and family, with gas, coal for fireplace—which is the usual method of heating employed—use of bathroom and service, can be had for $2 per week. Sufficient good healthy food can be obtained for $3 per week; these, with washing and laundry, may sum to $6; which extended over time of session, may be counted at $150. The remainder of the sum total may be justly depended upon to cancel all unconsidered necessities. The cost of the second course is, naturally, in proportion.

The clothing which is most satisfactory in the damp, rainy, moderately cold weather which prevails in and about "Glasgie cold an' dirt" during the winter season is heavy woolen underclothing and socks, a moderate weight dark suit, medium overcoat, a *waterproof* mackintosh, and heavy water-tight shoes.

PRACTICAL RESULTS OF SOME INNOVATIONS IN MODERN SHIPBUILDING.*

BY HENRY B. WORTLEY.

It may be of interest to the members of this Institution to lay before them the results of some departures from ordinary merchant shipbuilding practice, which have been embodied in eleven steamers (British built) owned by the Ocean Steamship Company and managed by Alfred Holt. These vessels, like all their predecessors in the line, are unclassed. Their moulded dimensions are 440 ft. by 52 1-2 ft. by 33 1-2 ft. They carry 8,200 tons of dead weight on a draught of 25 1-2 ft., the freeboard having been assigned by the British Corporation for the Survey and Registry of Shipping.

The profile is shown in Fig. 1, where it will be observed that the upper deck has no sheer; though for the sake of eye-sweetness, a slight sheer has been given to the bulwark rail.

The engines in normal condition indicate 3,600 horse-power, giving a continuous sea speed of 13 knots. Three of these vessels have now made two round voyages from this country to China and Japan, each covering a total distance of about 50,000 miles, and two of them have started on a similar maiden voyage of about 25,000 miles.

Amongst the innovations the following are the chief, viz.:

A. External: A rudder so hung that no stern frame has been required, and allowing the after deadwood to be cut away.

B. Internal: (1) The substitution in the main hold of two pillars in place of the usual numerous stanchions. (2) A 3-ft. frame spacing. (3) The disuse of cement on the ship's bottom inside the ballast tanks.

RUDDER, ETC.

The sterm frame of a merchant steamer is a feature which still retains to a large degree its primitive form and section. It has varied but little since its introduction into iron shipbuilding, and probably it had more arguments to justify its inception than can be claimed for its retention to-day. When introduced it was small in weight, size, and section, easy to forge, and formed a convenient method for finishing the run of a small ship. Since then the sizes of ships have gradually increased, and the stern frame has steadily advanced in weight, size, and section, until at the present time it is quite common to have stern-posts of 20 tons weight and 13 in. by 8 in. of rectangular section. It is needless to say that these posts are very clumsy to handle, even though scarphs have been introduced, and, despite the care bestowed in the manufacture, the results are not always satisfactory.

The commendable action taken by Lloyd's in the early eighties, in appointing specialists to survey forgings during the process of manufacture, and the circular issued in 1886 requiring all sections above 40 sq. in. to be welded under the steam hammer, have done much to minimize the evil; but it is not yet cured.

Cast steel was introduced for stern frames and rudders in the hope of overcoming bad welds, but a reaction has taken place against the use of this material, as many ship-owners have had unfortunate experiences of con-

*A paper read before the Institution of Naval Architects, London, England.

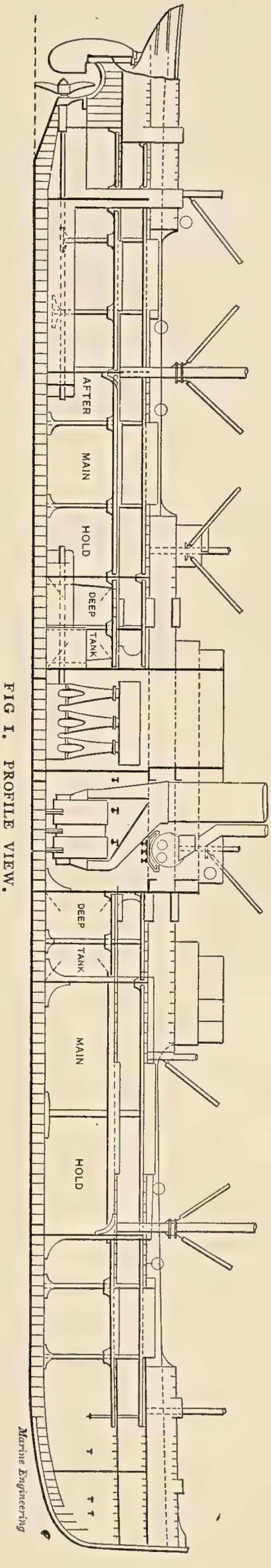


FIG 1. PROFILE VIEW.

traction flaws, necessitating the removal either of partial or complete stern frames and rudders.

The rectangular section of stern frame is most commonly used, although in some few of the largest vessels—especially twin-screw steamers—a U-shaped section of cast steel has been adopted for the inner post, while the aperture portion of the outer post has been retained of rectangular section. Now the strength of a stern frame of rectangular section is incompatible with the weight involved. Whether considered as a girder or pillar, the section is most primitive, and the number of broken stern-posts constantly seen do not justify them as being simple things to manufacture, or fitting contrivances for ending the after-body lines. When broken no other part of a ship of equal weight is so costly to repair, or requires so long a period for renewal. The form renders it incapable of being incorporated with the framing of the ship at reasonable cost, excepting at the transom, and at the upper portion of the inner or propeller post. Its whole weight is therefore sandwiched between the comparatively thin end plates of the shell, to which it is attached by a multitude of long rivets of a large diameter. The number of slack rivets observed in the after deadwood and the number of stern frames broken just below the boss clearly show that a considerable deflection takes place in thin deadwood during the ordinary working of the ship. The deadwood of the sailing ship has definite reasons to justify its existence, but it is difficult to find an excuse for deadwood in steamers. Its weight is generally greater than its buoyancy, it probably interferes with the efficiency of the propeller to an appreciable extent, and it certainly tends to prevent rapid manœuvring.

Most shipowners have experienced in greater or less degree the foregoing disadvantages of the ordinary forged or cast-steel stern frame and rudder; and many agree that the present type of stern is "found wanting." With a view to overcoming these difficulties, the following guiding principles were laid down for designing a stern and rudder for vessels of the Ocean Steamship Company's fleet: (1) That there be no useless after deadwood. (2) That a support at the heel of the rudder is not essential. (3) That forgings and castings be reduced to a minimum. (4) That the frame terminating the run of the vessel be compatible with the adjacent scantling. (5) That the frame be thoroughly incorporated with the ship's structure. (6) That the rudder be of the balanced type.

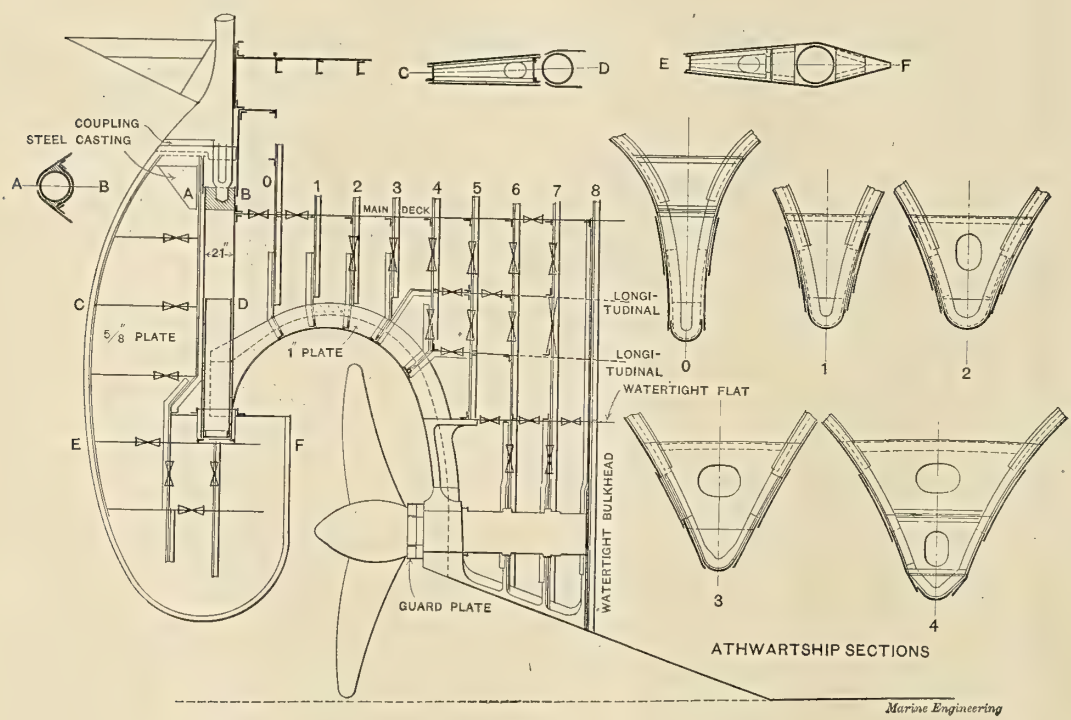


FIG. 2.

Several designs were made to meet these requirements, but the one illustrated in Fig. 2 was finally chosen. It will be noted in the diagram that the after end of the rudder is 8 in. thick, and forms the termination of the water-lines above the propeller arch. This gives a much longer and cleaner run to the vessel than is possible when the lines terminate upon the ordinary stern-post. (For comparison see Fig. 6.) The greaterst advantage however, lies in the increased thwartship width that these lines give to the stern, as it enables the requisite strength to be obtained from material of much less weight than the ordinary form of stern frame. The increased space also gives easy access to every rivet in the structure.

In this case the stern-post is made of a wrought-iron

tube 21 in. external diameter and 1 in. thick, with an internal liner at the lower part of the same thickness. The lower part of this tube forms the bottom pintle for the rudder.

The propeller arch is made of a Siemens-Martin steel plate 1 in. thick of U-shaped section. The after part of it is riveted to the sides and also the front part of the stern-post tube; and the forward part is carried down to the boss and riveted thereto. The boss is a steel casting—the size of which has been reduced as much as possible. It has one palm on the top riveted to the extension of a watertight flat, and another at the fore end of its lower part riveted to the after-peak bulkhead.

It will be noticed in the diagram that the framing of the ship is incorporated with every portion of the stern. which is of ordinary form, excepting that it passes through an octagonal eye in the casting just described, and forms an additional safeguard for working the rudder in case of accident to the coupling bolts. The lower part of the forged rudder stock forms the top pintle, and is housed in a cast socket fixed into the top end of the stern-post tube, where the whole weight of the rudder is taken.

It will be observed that this form of rudder is easily made watertight, and, therefore buoyant, the effect of which is to reduce the weight on the top pintle, which takes the downward thrust. The total weight of the rudder, rudder stock, tiller, &c., is about 15 tons, and the buoyancy of the rudder at the load draught is about 5 tons, leaving a downward thrust on the top pintle of 10 tons. The total weight saved in this system of con-

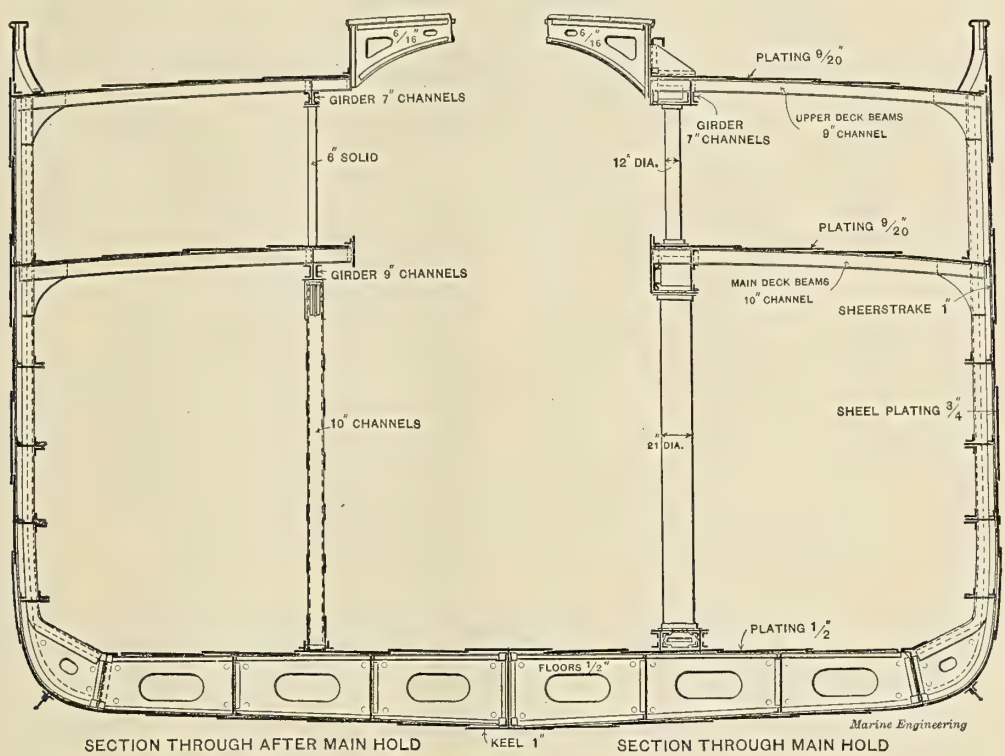


FIG. 3.

The frames above the arch plates are directly connected thereto, and two of the longitudinals are also incorporated with it. The top of the stern-post tube has an attachment to the main deck, and the bottom of it is well supported by the after sides of the arch plate. The base of the sloping part of the deadwood is formed by an extension of the keel plate. The rudder, as will be noted in the diagram, is built of plates and bars, and the interior is accessible in every part. The bow frame is of channel steel, and a flat bar at the fore side finishes the lower part of the rudder. The socket in the rudder for the lower pintle is of Siemens-Martin steel, lined with white metal working upon the lower part of the stern-post tube. At the head of the rudder is a small steel casting, with flanges forming a coupling for bolting it to the lower part of the forged-iron rudder stock, structing the stern against the ordinary type is about 10 tons.

In the initial stages of the design the chief argument brought against the system was that it would prove to be a trap for ropes and fishing nets. To prevent a rope or fishing net plugging the water grooves in the tail-shaft bearing, a guard plate was fitted over the stern-post boss, as shown in Fig. 2; but, although these steamers have covered collectively nearly a quarter of a million miles, no such difficulty has as yet been experienced.

A trial of the manœuvring power of one of these vessels was made in the Firth of Clyde in a dead calm and slack water. The vessel's draught was 18 ft. aft and 14 ft. forward. A long run was just being completed at 4,000 indicated horse-power, which gave a

speed of 14 knots. The helm was then put hard-a-port, and the diameter of the first half of the turning circle was found to be 1,170 ft., and the second half 1,070 ft. The time occupied in turning the complete circle was 5 min. 17 sec.

It was anticipated that the abolition of the after deadwood would tend to increase the manœuvring powers of these vessels to a considerable extent, but it was also feared that it might produce unsteady courses. To avoid this the vessels were fitted with bilge keels of rather greater length than usual, viz., 250 running feet on each side. As a result, the pilots and masters of these vessels report that they are easier to handle than steamers, in the fleet, of one-third their size, and that they make excellent courses. Experience has proved this departure to be a complete success, and very soon it will be embodied in eleven steamers of the fleet.

THE SUBSTITUTION OF TWO PILLARS FOR ORDINARY STANCHIONS.

The ordinary system of pillaring cannot be said to have many arguments to justify its existence. For the shipbuilder it is a crude and primitive contrivance, for the shipowner a costly nuisance; and in the performance of its functions it is more remarkable for its weight and obtrusiveness than its strength.

In text-books pillars are usually described as "short" and "long," in terms of their diameter, but in modern ships without lower, or orlop, decks, a new superlative would have to be invented to adequately describe the pillars now in general use. As they are of great length and have little resistance to transverse pressure, great difficulty is experienced in keeping them straight. Obstructing the stowage, they form a first aid to the stevedores in chocking off cargo; and as this is usually done with wedges, the pillars very frequently get bent. It therefore happens, even in the best regulated fleets, that a considerable percentage of the pillars are useless, either as struts or ties. Their resistance to deflection is also considerably modified by the character of their ends, and their value in many cases might be increased by greater attention to this detail. But perhaps the chief disadvantage of the ordinary system of pillaring occurs in vessels of great breadth, especially when quarter pillars are introduced. They break the stowage of the hold to such an extent that the obstructing pillars must frequently be removed, to admit bulky cargo, and very often they cannot afterwards be replaced until the cargo is discharged.

Under these circumstances, the deck is usually shored with wooden stanchions from the hold ceiling, and in some cases, where this is not accessible, the only alternative is to shore the deck from the cargo, in which case care must be taken to get a solid foundation for the stanchions, and to secure the cargo from damage. Such shores can only perform one of the two functions of a ship's pillar. They cannot easily be made into ties as well as struts. It is not surprising, therefore, that many cases are on record where these temporary shores have got adrift while the ship has been working in a seaway, thus causing the decks to collapse. Similar accidents to the deck are on record where the pillars have been carelessly replaced or left out altogether. Many accidents can also be traced to the negligence of leaving bent pillars unstraightened.

Now, in order to develop the full strength of a ship it is imperative that the top and bottom members of its girder should be rigidly tied together. It is also desirable from a shipowner's point of view that the number of pillars should be reduced to a minimum, and, if possible, the danger should be overcome that is caused by careless tampering with portable pillars, thus compromising the strength of the ship. Their diminution would also effect a considerable saving in time and money, which is generally incurred by the removal and replacement of portable pillars for the admittance of bulky cargo.

To achieve this end the main hold, shown in Fig. 4, was designed early in 1895, and has since been introduced into fifteen steamers of this fleet. The length of the hold is 75 ft., and it contains, with the 'tween decks, 6,250 tons of space, and yet its only obstruction is one pillar on each side of the hatchway. The floor of this hold has contained as many as twelve Lancashire boilers, each weighing 29 tons, which have been stowed without the removal of any part of the ship's structure. It may be of interest in passing to state that the lifting appliances at this hold have been tested up to 35 tons.

The principle adopted is that of compensating for two complete rows of stanchions by fitting two accessible box girders under the main deck, and extending the upper deck hatch coamings from bulkhead to bulkhead. The hatch coamings are converted into girders by fitting efficient flanges on the upper side, while the lower side is reinforced by fitting two channel girders under the upper deck beams. These fore and aft girders are divided into two spans, the extreme ends of which are supported by specially stiffened bulkheads, and the centre by a built pillar, the thrust of which is taken by a special stool fitted to distribute the stress over the double bottom. This system has been perfectly successful, experience proving it to be even more rigid than the ordinary system of pillaring.

It is a pleasure to record that T. and J. Harrison, of Liverpool, have fitted this system in a slighty modified form into two of their largest steamers, and have carried it throughout the length of the ship. I may add that these two vessels were classed at Lloyd's. I am also given to understand that Harland and Wolff have adopted the system, and have fitted it right fore and aft in five large vessels built for the Australian trade and owned by the White Star Line.

In the vessels forming the subject of this paper, it was considered sufficient for the trade in which they were employed to fit one hold in the manner just described and unnecessary to fit girders of such large spans in the remaining holds. However, to prevent any discontinuity of strength, the main hold girders on both decks were carried right fore and aft, scarphing into the engine and boiler casing; but as a less span was adopted in the remaining holds, the girders were made of a lighter character. This system is illustrated in the after main hold, Fig. 5.

The result of this system of pillaring has been most satisfactory, there being a complete absence of vibration, even when the vessels are in their lightest trim, and at all speeds of the engines up to a piston speed of 950 ft. per minute. When the main holds of these vessels were designed, it was predicted by some opponents of the scheme that it would be impossible efficiently to chock

the cargo to prevent chafage, owing to the absence of pillars, and that there would be heavy claims for damaged cargo. The contrary has been found to be the case, and experience has proved that these holds carry cargo with even fewer claims for chafage than vessels fitted with the ordinary system of pillaring. In other words, experience has shown that stanchions really tend to cause chafage.

THE 3-FT. FRAME SPACING.

In these vessels a 3-ft. frame spacing has been adopted. An increase in this direction has frequently been urged in times past, but the writer has been unable to discover any precedent in the merchant service where a greater spacing than 30 in. has been adopted. In a highly interesting and instructive paper, read before this Institution so long ago as 1873, Sir William White, in one of his conclusions on transverse framing, says:

It appears that an increase in the spacing of transverse frames favours the more satisfactory development of the strength of the skin plating, without any increase in cost of workmanship or weight of material. A change in this direction has been repeatedly enforced on weightier grounds than the above, but has long been postponed. There can be little doubt, however, that nothing but advantage, so far as strength in proportion to weight of hull is concerned, would result from modifying the present system of framing, widening the frame space, and combining with the reduced transverse framing some well-considered system of longitudinal framing.

Were it not for the fact that we have had repeated examples of the distrust of change common to shipowners, shipbuilders, underwriters, and registration societies, it would appear inexplicable that such an admirable paper, so logical and conclusive in its deductions, should have lain without actual result for so many years. This is more remarkable still when it is considered that the practical advantage of a wider spacing of frames is shared alike by shipbuilder and shipowner.

The reduction in the number of frames, reverse frames, floors, frame brackets, and, it might also be added, beams, coupled with the enormous reductions in the number of rivets used in the ship, and the greater accessibility of every part, especially the ballast tanks, are matters of advantatge to builder and owner alike. They appeal especially to the shipowner, because, with a given weight, a stronger and more durable ship can be produced.

The durability of steel ships has been much discussed owing to their scantlings being 20 per cent. thinner than iron. It has also been remarked of steel that the last stages of corrosion are more rapid than the first. This is undoubtedly due to the wasted material vibrating and throwing off all applications of anti-corrosive covering. If this is to be avoided, it follows that, instead of having a large number of comparatively thin scantlings easily wasted to the vibrating stage, it is better to have fewer and thicker parts, which will give greater initial strength, with the same weight, and be more durable in the end.

The midship section of these vessels showing the general scheme of scantlings is given in Fig. 3. It will be noted that an attempt has been made to combine with the 3-ft. frame spacing a simple longitudinal system. The ship's side is divided into cells about 4 1-2 ft. by 3 ft., the longitudinals keeping every portion of the shell

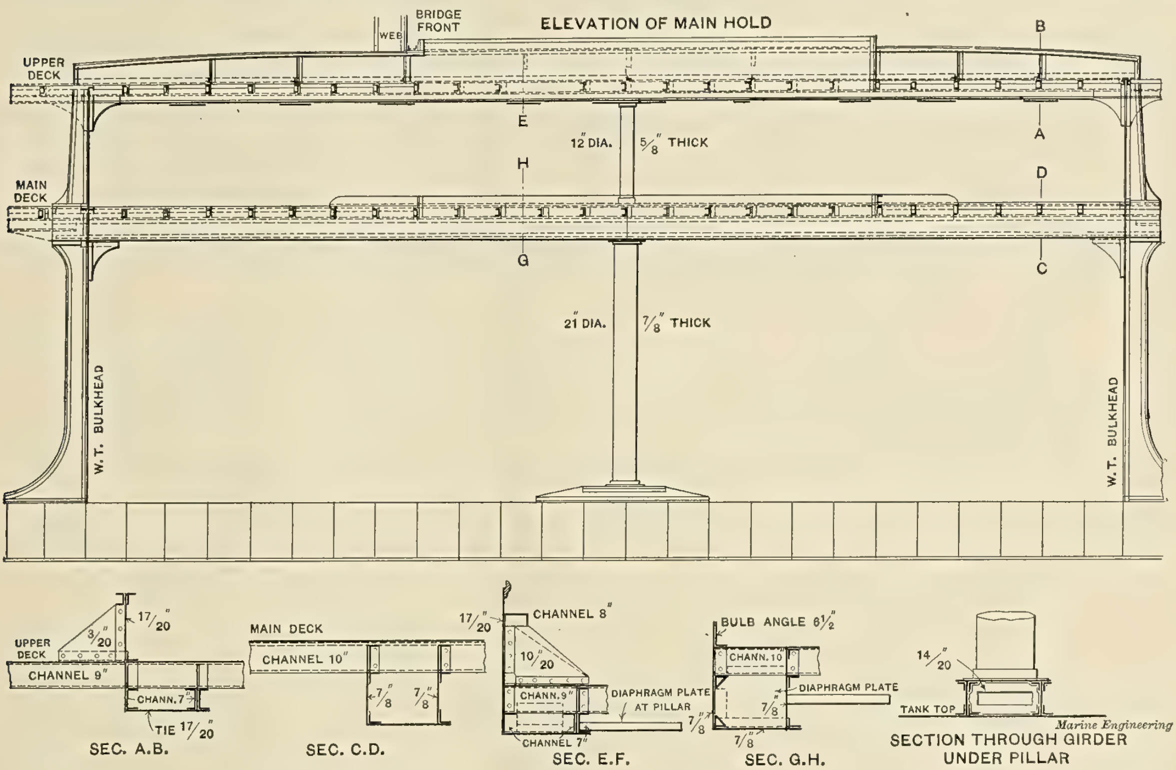


FIG. 4.

and framing well up to its work. The fore and aft girders, compensating for the omission of ordinary pillars, are also valuable longitudinal stiffeners to the upper flange of the ship-shaped girder.

None of the objections urged against the wider frame spacing have been experienced in practice. The ships have met with all kinds of weather and have stood both the pounding and hammering action of the sea with impunity. In port and roadsteads they are constantly surrounded by barges inflicting the usual amount of bumping. They also meet with the usual fending when entering locks or coming alongside quays. After considerable experience of this usage there is absolutely nothing to indicate in any of these vessels that the 3-ft. frame spacing is in any way inferior to the 2-ft spacing for resisting the local shocks that ships are subject to. It has now been adopted in this fleet of steamers as the minimum spacing.

bottom was introduced, the drainage could no longer get to the bottom of the ship, and provision was made for it to accumulate in the wings. These were therefore cemented.

It might have been reasonably supposed that, as the tank top supported the cargo, and carried all deleterious drainage to the wings, the cement would have been removed from the bottom and placed on the tank top. This, however, was not done, and experience has long since proved that, if the wood ceiling is frequently lifted and the tank top examined, or, better still, if the wood ceiling is dispensed with and the tank top exposed to view, it is a comparatively easy matter to preserve it from corrosion.

Now, as the tank top completely insulates the inside of the outer bottom from deleterious chemicals that may be in the ship, and as cement was originally placed there chiefly to preserve the bottom against their injurious action, the question may reasonably be asked: "Why put

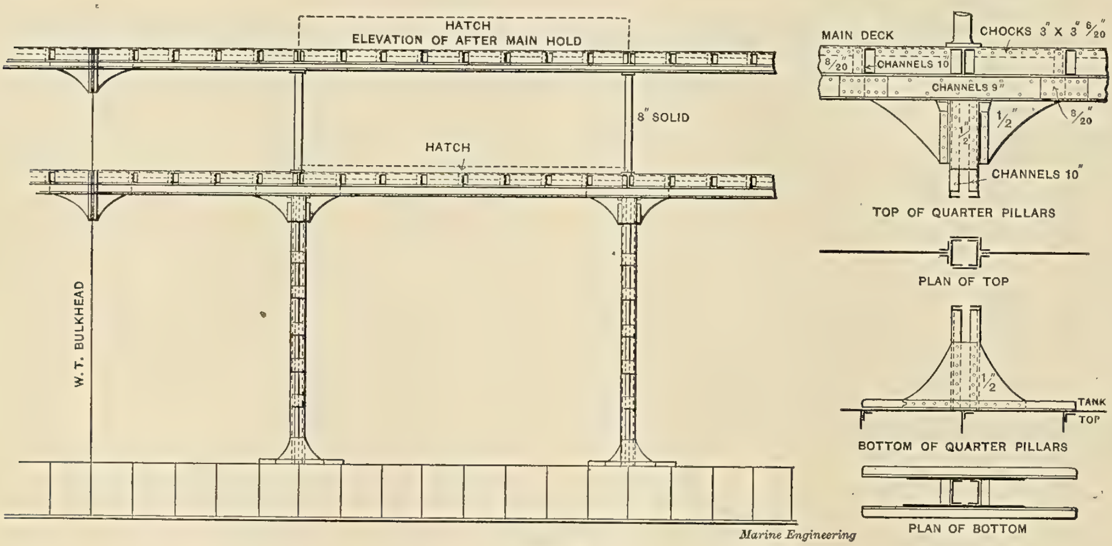


FIG. 5.

DISUSE OF CEMENT ON THE SHIP'S BOTTOM INSIDE THE BALLAST TANKS.

It was not until considerable experience of iron ships had been gained that Portland cement was adopted for preserving the inside of their bottoms. For some time this part of the ship suffered more severely from corrosion than any other. This was largely caused by the acids in the cargo draining into the bilges and setting up a chemical action detrimental to the iron. At that time sugar formed a staple trade for many iron ships, and the effect of this cargo on their bottoms was found to be most destructive.

Asphalt was at first adopted to insulate the iron from these ravages, but was found to soften in warm climates, and run down toward the centre of the vessel, leaving the higher parts and rivet heads bare. Portland cement was then tried, and has proved highly efficient in resisting the ravages of most chemicals carried in ships. It may be of interest to add in passing that sulphate of ammonia is an important exception. This chemical will turn the best Portland cement as soft as putty, and will then attack the iron, unless there has been sufficient cement to neutralize the acid. Now, when the double

cement there now?" The usual answer is "To preserve the rivet heads from the wash of bilge water." Now, if a shipowner can afford to carry bilge water, he can also afford to carry its antidote. But if he does not carry bilge water, what is the use of the cement? To try the truth of this reasoning, the vessels forming the subject of this paper have their bottoms inside the ballast tanks merely cement washed. The effect is a saving in deadweight of approximately 120 tons. To allow free drainage in the bottom, it is built clincher fashion, and for the same purpose the keel plate between the internal butt straps is cemented.

Again, for the purpose of insuring the tanks being pumped dry, the cement has been left off the keel plate at each centre suction, thus enabling the large trumpet-mouthed strums to be placed within 3.4 in. from the keel plate, which is an outside strake. To carry off the vapors common to all ballast tanks, they have been fitted with 6-in. ventilators. The upcast pipes ventilating the tanks under the engines and boilers are led to the forced-draught fan. Each vessel has been carefully inspected at the termination of every voyage, and after the most minute examination of the inside of the outer

bottom, no pitting or corrosion could be discovered, and the cement wash was found to be preserving the steel on the bottom as well as any other part of the tank.

IN GENERAL.

It may be of interest to add that these vessels' capacity for water ballast is about 3,000 tons, which, without bunker coal, immerses them to a draught of 18 ft. aft and 14 ft. forward. At this draught the propeller is completely immersed. This is owing, first, to the possibility of fitting, in a vessel with an overhung rudder, the centre line of the shafting nearer to the base line, and,

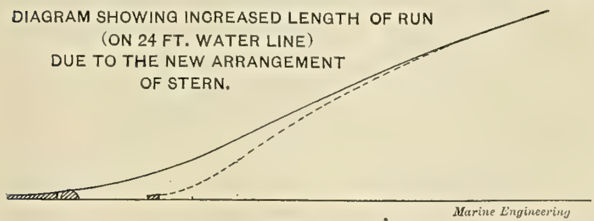


FIG. 6.

secondly, to the fact that a smaller diameter of propeller has been adopted than is usually customary. The advantages resulting from an adequate ballast draught and the complete immersion of the propeller in a seaway have been so effectually brought home to shipowners and underwriters by recent events that I need not dilate upon them. The economy is apparent, not only in speed, but likewise in the immunity from shock and consequent disaster to every part of the machinery, from propeller tip to stop valve. The diameters of propellers in the merchant service are usually designed to meet the load-draught requirements, but there are many cases where a better balance can be secured between load and light-draught performances by adopting propellers of less diameter than those now generally in use. In any vessel where the propeller is not completely immersed at ballast draught, it would be advisable to take the diameter as a factor in determining the size of the shafting.

The interesting and unusual operation of shortening a steamer has been carried out at the yard of the E. J. Codd Co., of Baltimore, Md. This boat, the *Martha Stevens*, was recently purchased by the Merchants' Transportation Co., of Trenton, N. J., and being too long by 25 ft. to allow of her operation in the Delaware and Raritan Canal, this length has been taken out. This operation leaves the boat 135 ft. long.

CHICAGO DRAINAGE CANAL.—The recent opening of the Chicago drainage canal has greatly increased the difficulties of navigation in the Chicago river, and for this reason the local authorities have planned early improvements which it is believed will eventually make the conditions better than before the opening of the canal.

OCEAN RACE.—A long distance ocean race by sailing ships is reported having ended recently at Queenstown. The British ships *Kirkcudbrightshire, Crown of Germany, Benicia* and *Sierra Miranda* left the Columbia river in company December 15 last, and the *Kirkcudbrightshire* won the race, arriving at Queenstown after a passage of 120 days. A purse was made up by the captains before sailing, and this was awarded to the winner of the race.

LAUNCHES—HOME AND FOREIGN.

S.S. AMERICAN.—At the Roach yards in Chester, Pa., on July 14, was launched the steamship *American*, of the American & Hawaiian Line. The ship was christened by Mrs. F. Farwell Long, daughter of John B. Roach. The *American* is the largest freight steamer ever built in the United States, and is one of a fleet of five, two others similar being under construction at the Roach yards and two at San Francisco, with perhaps more to follow. The dimensions of the ship are as follows: Length over all, 435 ft.; beam, 51 ft.; depth, 33 ft. to water bottom; gross tonnage, 6,000 tons. The scantlings of the vessel are in accordance with Lloyds' three-deck rules, and she will receive the highest rating in this class. The design calls for seven complete steel water-tight bulkheads and one partial bulkhead. A double bottom extends from the collision to the afterpeak bulkhead. The tanks in this double bottom have a capacity of 1,250 tons. The propelling machinery will consist of a single vertical triple expansion engine with cylinders 27 in., 45 1-2 in. and 76 in. dia., by 48 in. stroke, designed to develop 2,500 I.H.P. Steam will be supplied by four single end Scotch boilers, 14 ft. 9 in. dia., and 10 ft. 6 in. long. In addition there is a donkey boiler, 9 ft. 6 in. dia. and 10 ft. long, built for 90 lb. pressure. The coal bunker capacity is 1,500 tons. The *American* has been designed to carry 8,250 tons of freight on a draft of 26 ft., at a mean sea speed of 10 knots.

S.S. VADERLAND.—At Clydebank on July 12 was launched the new Red Star Line steamer *Vaderland*. She is the first of four new steamships which the International Navigation Co. is building for the Red Star Line to ply between New York and Antwerp, stopping each way at a French port as well. The *Vaderland* is 560 ft. long, 60 ft. beam, and 42 ft. deep, with a gross tonnage of about 12,000 tons. Her average sea speed will be about 16 1-2 knots, placing her in the intermediate class of steamers. All four of the new ships will be similar and will have twin screws and quadruple expansion engines.

EIDSVOLD.—A new coast defense ship for the Norwegian Government has just been launched at the Elswick Works on the Tyne. She is 290 ft. long, 50 ft. 6 in. beam, 16 ft. 6 in. draft, with a displacement of about 3,900 tons. Her engines are of 4,500 I.H.P., with Yarrow boilers and are intended to give a speed of about 16.5 knots. Her armament consists of two 8.2 in. and six 5.9 in. b.l. rifles with eight 12 pdr, and six 3 pdr. quick firers. The armor protection consists of a belt of 6 in. Harveyized steel, with a 2 in. steel deck, and 5 in. armor on the turrets.

S.Y. VALDA.—At Lawley's boatyard, South Boston, Mass., the steam yacht *Valda* was recently launched. This yacht is schooner rigged 120 ft. long over all, 95 ft. long on the water line, 14 ft. beam and 6 ft. draft. She is of semi-composite build, and has four transverse water tight bulkheads. The engine is triple expansion with cylinders of 9, 14 and 21 1-2 in. dia. and 10 5-8 in. stroke. The designed speed is about 13 1-4 knots.

Russian A.C. Bayan.—At the yards of the Forges et Chantiers de la Méditeranée, near Toulon, France, was recently launched the Russian armored cruiser *Bayan*. This vessel is the only one of her class in the new Russian programme, being smaller than the *Rossia* and quite distinct from the protected cruisers now under construction in America, Germany and Russia. She is of 7,800 tons displacement, 445 ft. long, 59 ft. beam and 21 ft. draft. She has twin screw engines of 16,500 I.H.P., steam being supplied by 26 Belleville boilers. The designed speed is 21 knots. The armament will consist of two 8 in. and eight 6 in. guns, with twenty 2.9 and seven 1.8 quick firers. The armor belt is 6 ft. wide, 4 ft. below the water and 2 ft. above and varies from 4 in. to 8 in. in thickness. Above is somewhat slighter protection given by a belt 3.2 in. thick. The deck is from 1.2 in. to 2 in. in thickness, while the turrets have protection of 6 in. in thickness.

S.S. Cornell.—The new steel steamer *Cornell* for the Carnegie Line was launched July 11 at the yards of the Chicago Shipbuilding Co. As with the other boats of this line, the Japanese custom of releasing a basket of doves was followed, rather than the use of the traditional bottle of wine. The *Cornell* is 440 ft. long, 50 ft. beam and 26 ft. deep. She has a dead weight ore capacity of 6,000 tons. The time occupied in her construction has been about six months.

Torpedo Boat Dale.—At the Trigg Shipyard in Richmond, Va., on July 24, the torpedo boat *Dale* was launched. Miss Mary Hassell Wilson, of Philadelphia, a descendant of Commodore Robert Dale, named the vessel. The *Dale* is 245 ft. length over all, 23 ft. beam, 6 ft. 6 in. draft, and has a displacement of 420 tons. She is one of the class of 28-knot destroyers for which contracts were let soon after the close of the late war with Spain.

S.S. Elmore.—At the yard of Joseph Supple, in Portland, Ore., on June 30 last, the steamer *Elmore* was launched. This ship is designed for the Tillamark trade and the aim has been to give her a large freight capacity on sufficiently light draft to enable her to get in and out of the harbor with regularity. At the same time she has been given such form as will insure good speed.

Ferryboat Kittery.—On July 15, at the yard of David Clark, Kennebunkport, Me., was launched the ferryboat *Kittery*. She is intended for use between Portsmouth and Kittery. All her machinery was in place as she left the ways, and she will soon proceed to Portsmouth under her own steam.

S.S. Emma Reis.—After several unsuccessful attempts the steamer *Emma Reis* was launched on July 13 at Milford, Del. She is 115 ft. long, 20 ft. beam, 8 ft. draft, and is intended for passenger and freight service between Milford and Philadelphia.

Tug Richard Caswell.—The steel tug *Richard Caswell* was launched July 7 at the yard of the Columbian Iron Works. This tug is intended for use in connection with the Government improvements about to begin on the Cape Fear River, North Carolina. She has a length of 84 ft. 6 in. over all, a beam of 18 ft. and a depth of 9 ft. 4 in.

Oyster Dredge.—At McDonald's yard, Fairhaven, Ct., a modern type of oyster dredge has recently been launched. The owners are the Narragansett Bay Oyster Co. The boat is 40 ft. long and has a 16 horse power Globe gas engine for propulsive power. The boat will be used for catching star fish and taking up oysters on the Company's beds in Narragansett Bay.

Barge Major Barrett.—At the yards of the Jackson & Sharp Co., in Wilmington, Del., on June 20 last, was launched the sea-going steam barge *Major Barrett*, constructed for the Barrett Mfg. Co., of Philadelphia, Pa. This barge is built for sea-going purposes and is designed especially to carry tar and pitch between Philadelphia, New York and Boston.

Tugs Genessee and Mahony.—These two steel tugs built for the L. V. R. R. Co., were launched at the shipyard of the Burlee Dry Dock Co., in Port Richmond, on June 21 last. The boats are each 105 ft. long, 21 ft. beam and 12 ft. 6 in. depth. They are each fitted with single screws and engines of 650 I.H.P.

Prinzessin Victoria Luise.—This magnificent new twin screw cruising yacht of the Hamburg-American Line was launched at Kiel June 29 last. At the special request of Emperor William, the christening ceremony was performed by Countess Von Waldersee, who was formerly Miss Lee, of New York.

Tug Ada Weaver.—On June 28 last at the yard of J. W. Brooks & Son, Madison, Md., was launched a new wooden tug built for Philip Weaver & Son, of Baltimore. The boat will be taken to Baltimore to receive her machinery at the works of the E. J. Codd Co.

S.S. Mineola.—At Sunderland, England, was recently launched the first of the steel steamers building for C. W. & J. Hogan, of New York. The dimensions of the *Mineola* are: Length b.p., 390 ft.; beam, 51 ft.; depth, 31.4 ft. She is provided with single screw triple expansion engines.

S.S. Devonian.—The Leyland Line steamer *Devonian*, a sister ship to the *Winifredian*, was launched on June 28 last at Belfast. Her dimensions are as follows: 552 ft. 5 in. long, 59 ft. 3 in. beam, and 28 ft. 9 in. deep.

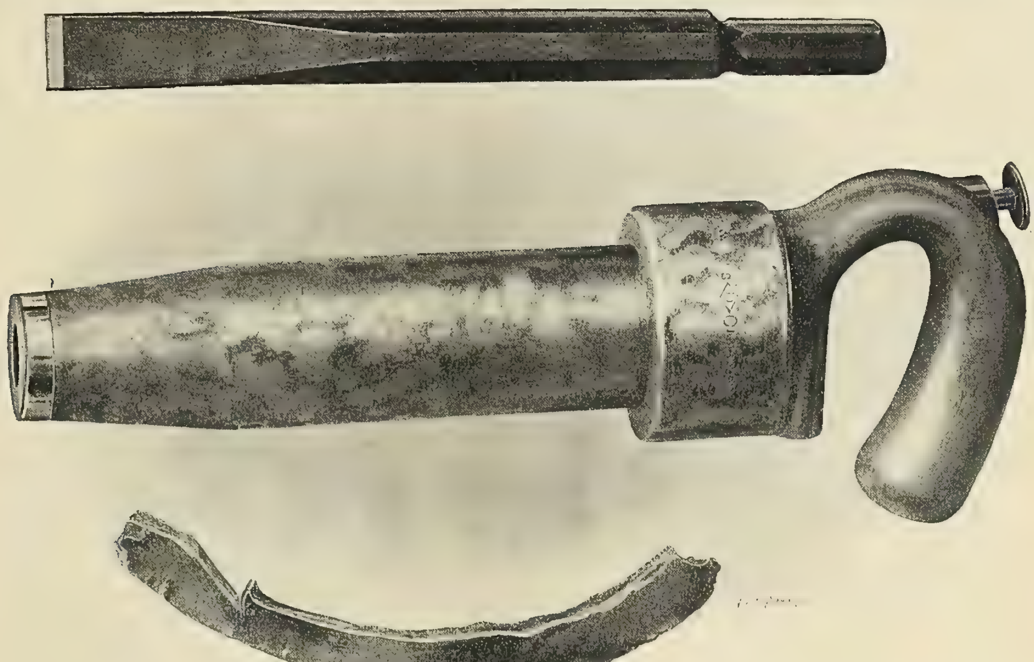
Salvage Case.—The owners of the British tug *Blazer* have been awarded $15,000 by the Admiralty Court for services rendered the Anchor liner *Persia*, while the latter vessel was under charter to the British Government as a transport. The *Persia* was on her first outward voyage to the Cape of Good Hope in the Government service, and when a few miles from the Cape de Verde Islands, broke her shaft. Under the influence of the trade wind the vessel commenced to drift toward the rocky shore, finding bottom to anchor in when within a mile of the rocks. A boat had been sent away to get help from St. Vincent, and fortunately found the tug *Blazer* in the harbor with steam up. The tug immediately went out and brought in the *Persia* safely, and repairs were then effected. The *Persia* was valued at $100,000, and had a valuable lot of stores in her hold. Besides saving the ship for her owners, the tug enabled them to complete their contract with the Government, a matter which would call for the consideration of the court.

IMPROVED APPARATUS.

Pneumatic Hammer.

The hand pneumatic hammer has to-day become a necessity in all ship yards and shops where chipping is to be done, and it is also rapidly making its way into use for the driving of rivets in all classes of riveted work. One of the drawbacks to the use of the tool has been the jar communicated to the hand and body of the operator.

In the hammer shown in the cut the claim is made that a tool has been produced which will do the heaviest duty required without excessive jar or shock upon the operator. The hammer is of the "valve long stroke" type, the valve being of substantial design and not liable to break. The handle is firmly fastened to the body by a collar-locking nut, which can be easily removed; and all working parts are made of steel carefully hardened and accurately ground to gauge, insuring durability and long wear.



PNEUMATIC HAND HAMMER.

The handle has a pistol grip, and the admission valve is so designed that the operator has an instant and sensitive control of the strength of the blow he wishes to strike, so that even with the largest size he can instantly change from the full power of the hammer to the lightest cut desired.

The shank of the chisel does not require machine shop fitting, it being only necessary to make it a good smith-shop fit in the bushing of the hammer, and to cut the shoulder the proper length from the end.

These hammers are made in three sizes, weighing from 10 lb. to 12 1-2 lb., and consuming from 15 cu. ft. to 21 cu. ft. of air. They are guaranteed by the makers, Thomas H. Dallett & Co., of Philadelphia, Pa., to be well made in all respects, and against all defects for a period of one year.

Modern Prismatic Marine Glasses.

For many years the accepted form of field and marine glass was the long single-barreled tube with the erecting eye-piece. These, however, were of awkward length, difficult to hold steadily, and lacking in illumination for the higher powers. Later came the double or binocular form, invented by Galileo and improved by Dolland, which until a few years since remained the standard form of marine glass. About 1850, however, the Italian engineer, Porro, invented a form of double reflecting prism which would effectively serve to invert the image formed by an astronomical telescope, and therefore to show erect an object seen by such an instrument. This discovery, however, bore no fruit until 1895, when Carl Zeiss, of Jena, took up the study of the best optical combinations for field and marine glasses. It was then that use was found for Porro's discovery, and by the application of such prisms it was found possible not only to reduce their length by more than one-half, but also to replace the clumsy erecting eye-piece with the simple astronomical eye-piece, thus securing compactness of form with the benefit of a long focus. The chief advantages claimed for this form of optical combination are three: A much larger field of vision, more perfect definition, increased light efficiency. Since the first advent of glasses of this character several of the leading makers have taken the matter up, and different forms of such glass are on the market, all, however, more or less immediately related to the Zeiss form and design. More recently the Warner & Swasey Co., of Cleveland, O., have taken up the study of this problem, and as a result have produced the glass shown in the figure.

This company brought to the investigation of the problem a long experience in the construction of optical tubes, ranging from those for the great Lick and

Yerkes telescopes to the telescopic gun-sights and range finder telescopes and sextants as used by the army and navy.

It was the especial aim of this company to develop independently, and from the scientific and engineering standpoint, the best possible type of field and marine glass of the Porro prism form. As one notable result of this study, it is stated that the total number of pieces contained in the form developed is less by twenty

PRISMATIC MARINE GLASSES.

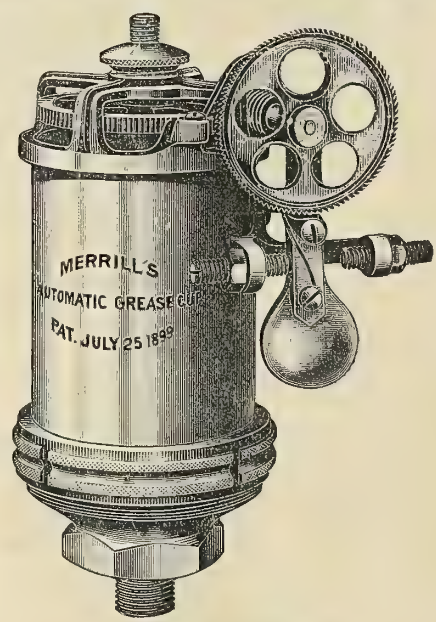
than will be found in other instruments of similar type. This is a gain in simplicity, without at the same time involving any sacrifice in use, efficiency, or convenience.

An especial point is also made of the fact that by the combination of each eye tube, cap, and hinge in a single piece, all liability of change in the alignment or collimation by accident or rough usage is avoided. The two sets of optical parts with their tubes are hinged together as shown in the cut, thus permitting of an adjustment for varying distances between the eyes. The adjustment for focus for each tube is also separate, thus providing for the commonly existing difference in focus between the two eyes of most persons. A convenient numbered scale is also provided, so that once these adjustments are determined they may be readily made again at a future time.

The field covered by this instrument has an angular opening of 4 3-4 degrees, and the magnifying power is 8 diameters, while the weight is but 11 ounces. This degree of magnification is believed to be as much as is consistent with the best illumination and with the possibilities of steadiness for a glass held in the hands. A somewhat larger size, giving a magnification of 10 diameters, is also made, but requires an especially steady hand to give the best results. Messrs. Warner & Swasey publish a little booklet giving full description of these glasses, together with hints as to their use, and an interesting list of astronomical objects which may be studied with interest and profit by their aid. This booklet will be sent to any address on application.

Automatic Grease Cup.

This cup is intended for attachment to any reciprocating or oscillating part of engines or machinery requiring constant and reliable lubrication, such as crossheads, connecting rods, eccentric straps, etc. As it feeds grease instead of oil, it may be attached in any position desired, feeding vertically upward or downward, horizontally, or at any angle. The cup feeds only when the part to which it is attached is in motion, so that no feeding or loss can occur after the engine is shut down. The base of the cup is screwed firmly into the part to be lubricated, while the body is attached to the base by the union nut or enlarged ring at the top. When this is unscrewed the upper part is all taken off together, the barrel is filled with a charge of grease, returned, and clamped into position by the union nut. The feeding is accomplished by the pressure of the piston, and this pressure is applied by the vibration of the pendulum seen at the front. By the adjustment of the stop screws at the side, the pawl attached to the pendulum may be made to take from one to six, or more, teeth of the ratchet wheel for each vibration of the pendulum. On the ratchet wheel shaft is a worm which meshes into the large worm wheel at the top. The central screw or spindle is



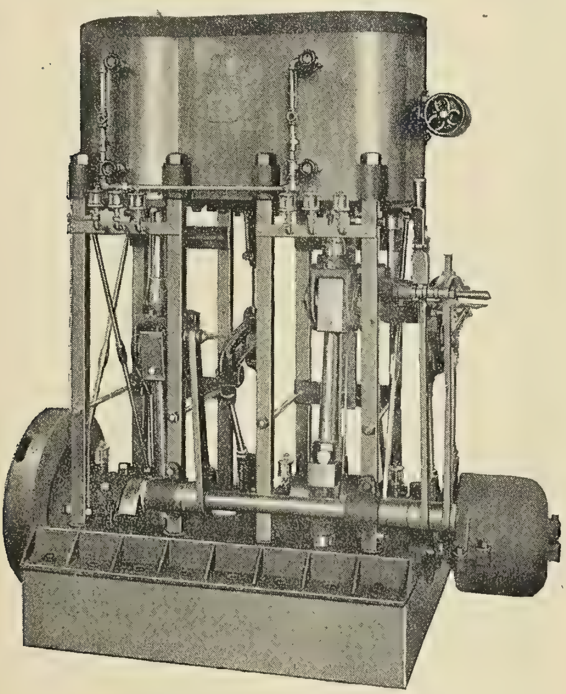
AUTOMATIC GREASE CUP.

splined, and revolves with this wheel at the same time that it travels downward by the operation of its thread in the central nut, which is screwed into the bracket or guide at the top. As long as the vibrations continue the feeding goes on, until the piston reaches the bottom and the grease is all expelled. To raise the piston for refilling the barrel, the central nut, which has a milled and notched head, is unscrewed from the

bracket, the piston is pulled up, the nut is whirled down the screw by hand, and screwed tight in its place again. The ratchet wheel may be pulled round by hand until the slack is taken up and feed is fully established, and if at any time it is desirable to feed in an extra quantity of grease, this also may be done by turning the ratchet wheel. The lubricator may be made of any size and for any rate of feed desired. Any of the usual kinds of grease may be used in the lubricator, and any percentage of pure graphite may be mixed with it. The worm is of steel, the pawls are of steel hardened, and the wheels are of hard bronze. The lubricator was designed and patented by G. U. Merrill, of Paterson, N. J., and is made and sold by James L. Robertson & Sons, 218 Fulton street, New York.

Reeves Compound Yacht Engine.

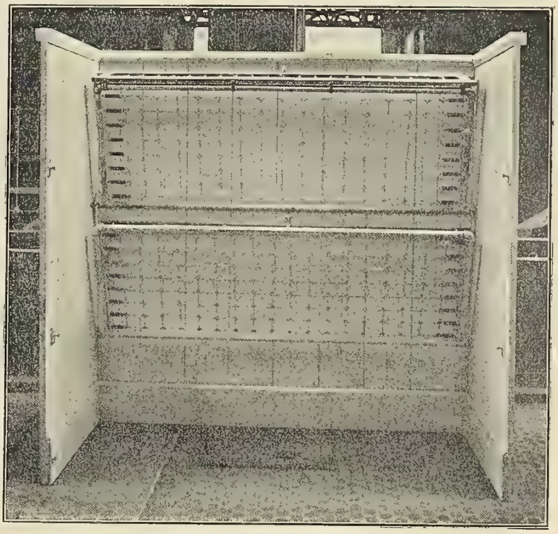
The especial feature of the yacht engine shown in the cut is found in the valve gear. The valves are of the simple piston form, and are each operated by a link. A special device for controlling the links enables the low pressure cut-off to be set at any desired point, independent of the high pressure link. At the same time, when it is desired to stop or reverse, it is only necessary to operate the main lever, both links being under its control so that they move as one. In this way the low pressure link can be set in such position as may be determined by experiment for the best results at any given point of high pressure cut-off, but without introducing any additional difficulty of manipulation. These engines are made in various sizes by the Reeves Machine Co., of Trenton, N. J., who are prepared to furnish estimates either for engines alone or for complete steam yachts.



COMPOUND YACHT ENGINE.

Metallic Berths.

Among the many details which mark the modern improvement in ship fittings, by no means of least importance are those which have transformed the old cumbersome, dirty, vermin-breeding berth into the modern metallic cleanly substitute. The berth shown in the adjoining cut is made by Lein, Irvine & Co., of New York city, and has been designed especially with a view to simplicity and durability. When not in use they can be folded up and out of the way, thus greatly increasing the freedom in the living spaces of the ship. They are also so made that they may be taken down and put up without the use of special tools. With the upper berth folded up out of the way, the lower berth can be used as a lounge or couch. The same company also manufactures all forms of steel and wood bed springs, mattresses, pillows, and bedding equipment.



METALLIC FOLDING BERTH.

On June 28 the *Oregon* while proceeding from Hong Kong to Taku struck on a pinnacle rock in the Miao-Tao strait in the gulf of Pe-Chi-li. There was a dense fog and the ship had anchored, sent out boats to sound, and then later got under way, soon after striking on the rock. At first grave fears were entertained that it would be impossible to save her, and that after her glorious career at Santiago, she would become a wreck upon a treacherous rock off the China coast.

It is not too much to say that the whole nation rejoiced when, on July 5, Secretary Long received a telegraphic report that she had been floated, and later another to the effect that the injuries were not serious and that comparatively simple repairs would be sufficient for present purposes. He immediately wired congratulations and instructions to make only such repairs as were needed to place the ship in condition for service, so that we may soon hope to learn that, as Secretary Long called her, the *Constitution* of the present generation has again taken her place in the fleet, like her prototype of former years, fearing nothing and ready for whatever service may be required.

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

NEW YORK and its environs has experienced fires many and disastrous, but perhaps none which came so like a thunderclap from clear sky as the conflagration of June 30, which resulted in the destruction of the docks and ships of the North German Lloyd Co., in Hoboken.

The account of this fire, as summarized elsewhere in the present issue, furnishes food for serious reflection and gives material for many lessons. Of these we can here refer only briefly to the more prominent.

The rapid spread of the fire seems to have been due to the existence of a series of favoring conditions: the presence on the docks of large quantities of combustible cargo; the presence of wood in the docks and sheds dry and more or less soaked with oil and tar; the existence of a high wind and the absence of adequate means for fire control at the dock itself. In other words there was the presence of all elements necessary to the rapid spread of the fire; and the absence of means adequate for its control. These facts point to two conclusions: The need of fireproof construction, so far as may be feasible, for docks and sheds, and the need of more efficient apparatus for fire control at the docks and ready for instant use. In the first moments of this fire a single stream of water well directed would have controlled the situation and prevented the entire horrible catastrophe.

Another fact impressed by this fire is the enormous amount of inflammable material, considering both fittings and cargo, which is contained in a modern ship, even though she is primarily a structure of steel. As a general truth, this, of course, is well known, but the possibilities of rapid and fierce conflagration in such structures have received new and startling demonstration in the Hoboken fire.

We can hope for little improvement, of course, so far as the cargo is concerned, but relative to the ship herself it is a question if much might not be done by the adoption in some measure of the warship fireproof style of construction and fitting. While not carrying these ideas to the same extent something might be accomplished by a decrease in the amount of wood fittings and the omission from the passenger ship of tons and tons of inflammable material, which contribute only to forms of barbaric decoration, and which have no place where they may by any chance play a part in endangering human life.

The truth is that while the subject of fireproof construction for structures on land has attracted great attention and study and has been carried to a high degree of development, the fittings and equipment of ships have been carried out in almost entire disregard of these considerations. It is time that the possibilities of danger from these sources were more keenly realized than they have been hitherto.

The most shocking feature of the catastrophe was the loss of human life. Nearly three hundred persons burned alive or drowned as the result of a burning cotton bale. It appears that many of these deaths, perhaps most of them, occurred by the imprisonment of the victims below decks, either by closed hatches or by the fire itself. The appearance of faces and waving arms at the deadlights told a story of human agony of mind and suffering of body, which those who saw will perhaps long be unable to forget.

Had a few of these openings been of sufficient size to admit the passage of the body, many or most of these victims might have been rescued. It is not a question of enlarging all of the deadlights; one or two in each compartment or passage would have perhaps been sufficient. The thing is perfectly simple, only slight enlargement would be required, but the especial need of such ways of exit or escape have perhaps never before

become so plainly apparent, and so it has not attracted the attention which its importance merits.

The lack of organized and calmly directed effort to control the fire and to save human life seems also a distressingly sad fact. The wholesale charges made against tugboat captains and crews are admittedly incorrect or founded on exaggerations. While doubtless examples of undue greed were not lacking, it is not to these charges that we refer, but rather to the absence of means, material or human, adequate for grappling and dealing with such a situation. If detachments of bluejackets from the Navy Yard could have been hurried to the scene, men fearless of danger, devoted to duty, and in charge of cool and experienced officers, if such squads of men could have been on the spot with the sole aim of saving human life and property, perhaps the tale of the lost might have been lessened.

The cost in human life was terrible and in property enormous. Let us hope that some of the lessons so plainly shown by this catastrophe may sink deep into the hearts of those who have the power to move for better things in the future.

THE British *Belleisle* gunnery experiments have naturally attracted much attention from the technical press, both at home and abroad, and "lessons" many and varied have been drawn. Among these we have noted one regarding the ordinary form of small boats, the certainty of their destruction if carried in the usual places on deck, and the uselessness of depending on such means either for escape or for boarding. This lesson, however, can hardly be called new. for it was long ago learned and practised in both the Chino-Japanese and the late war between the United States and Spain. Valuable lessons are doubtless to be drawn from these experiments with the *Belleisle,* but the danger to small boats is already too well known to need further demonstration in this manner or at the present day.

What is now needed is an adequate substitute not subject to the same risk of destruction. The suggestion of collapsible boats which may be stowed below or in a place of relative safety is perhaps worthy of consideration, but at the best such could be only considered as a last resort provision. On the other hand the increasing evidence that the sinking of an armor clad ship is not as likely a result of naval warfare as we have been led to believe may indicate that the need of boats for escape will be correspondingly decreased.

On the contrary, however, the need of boats for boarding or for making sure of a victory may be as great as ever, and the ship which is shorn of every possible means of clinching a victory and of readily placing a prize crew on board, will to that extent fall short of the ideal toward which all naval construction must aim.

AT the beginning of the present decade the few vessels of the type of the *Paris* and *Teutonic* represented the forefront of the advance in fast ocean steamships, and even now these may still be called fine ships. Early in the decade, however, came the *Campania* and *Lucania* with many head shakings as to the policy of ships of such size, only to be far distanced more recently by the *Oceanic.* Then came also the Germans with their monsters culminating in the *Kaiser Wilhelm der Grosse* and the *Deutschland,* whose maiden trip we summarize on another page. Comparing the *Paris* with the *Oceanic* we find a nearly doubled displacement for the latter, but with no sensible increase in speed, such being the purpose of the designers. Turning to the *Deutschland,* however, we find a speed of 23 knots, an advance of from two to three knots for the decade. Unless all signs and rumors fail, moreover, the *Deutschland* will not long have the field uncontested, and we may look with confidence for advances in the coming decade perhaps not less notable than those of the past.

WE publish elsewhere a communication from a correspondent relating to certain improvements in the development of power, for the propullsion of steamships, and incidentally, we suppose, for other purposes as well. We suspect that our correspondent has either been indulging in a "midsummer night's dream," or else that he is a bit of a wag and sends this letter as his contribution to the usual midsummer crop of freak ideas on this and similar subjects. We publish, however, the communication without prejudice, and assure our correspondent that the prospects for success by the methods which he outlines are quite as good as by those involving either liquid air, or electricity in the manner discussed in our issue for July, and to which he refers at the opening of his letter.

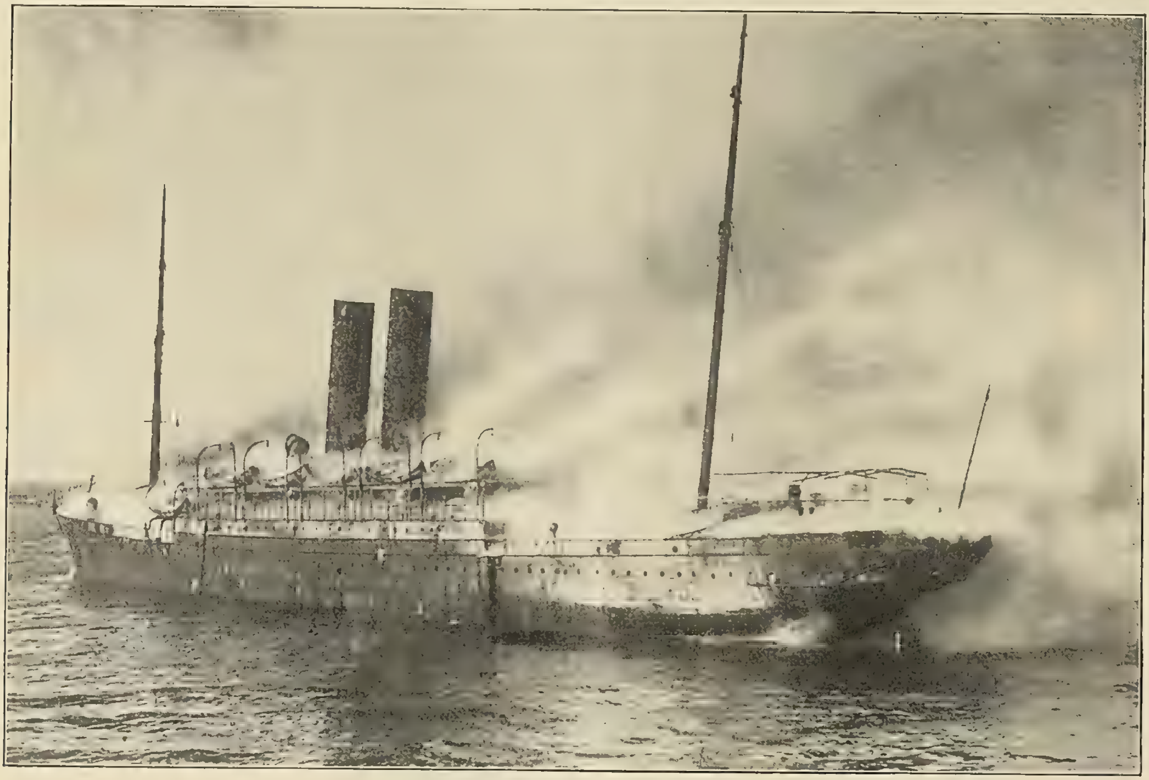
SHIPS AND DOCKS OF THE NORTH GERMAN LLOYD STEAMSHIP CO. DESTROYED BY FIRE.

On the afternoon of June 30 occurred the most appalling and destructive fire ever known in the piers and shipping of the Port of New York. Nearly three hundred lives were lost either by burning or drowning, the four large piers and sheds of the North German Lloyd Co., at Hoboken, with large quantities of cotton and general merchandise were completely destroyed, the steamers *Saale, Bremen* and *Main* were for hours raging furnaces, and when the fires died down for lack of further material on which to feed, little was left but the metallic parts of the structures, and much of that in a twisted, blackened and useless condition. The new steamship *Kaiser Wilhelm der Grosse* was also badly scorched, but fortunately escaped without more serious injury. The total loss of property has been variously estimated from $6,000,000 to $10,000,000, only in part covered by insurance.

The fire seems to have started in a bale of cotton, just how is not clear, but once under way it spread with almost inconceivable swiftness, due in large measure to the inflammable materials at hand and to the high wind prevailing at the time. In a short quarter of an hour from the start, the four piers and their warehouses were enveloped in the flames, which soon extended to the ships moored alongside. The *Kaiser Wilhelm der Grosse* was quickly pulled out and escaped with but slight injury. The *Saale* drifted out and down the stream, burning as she went her way, a menance to all shipping in her path, while helpless human beings were imprisoned and perishing below. The *Bremen* also floated out into the stream in like condition, while the *Main* burned and sank near the docks, also with its complement of perishing humanity.

On the *Main* sixteen men took refuge in the coal bunkers, lived through the terrible experience, and were rescued after the flames died down. In addition to these large ships several barges and lighters loaded with cotton and other merchandise caught fire and either burned at their moorings, or drifted out into the stream and burned as they made their way down the river. On these also men were burned, or jumping into the river were drowned or rescued by passing boats.

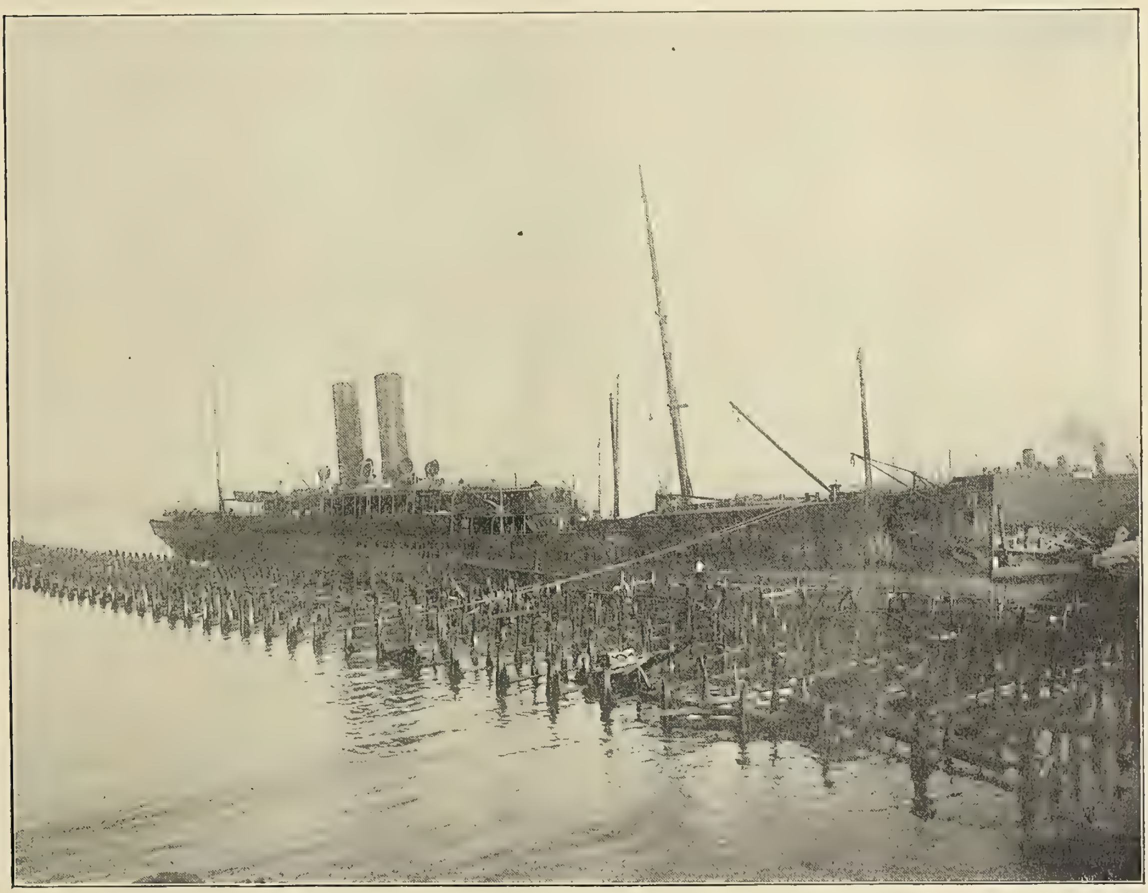
The flames were also communicated to the Campbell stores adjacent to the piers, in which were stored large quantities of jute and whiskey. These burned with such fierceness that the firemen could not come within fighting distance, and the flames had their own way until the buildings were entirely destroyed.



S. S. SAALE ON FIRE AND DRIFTING DOWN THE RIVER.

The most terrible feature of the fire was the loss of life by burning and drowning. So rapid was the spread of the fire that before due realization was had, or warning could be given to those in the holds of the ship, they were enveloped in flames and all escape was cut off. The lower portholes were open and to these the imprisoned victims crowded, shouting for help or waving signals of distress. But all in vain, for while within easy sight and hearing of those in boats about them, no help could be furnished, and overcome by the heat they perished before the eyes of those looking on, but powerless to aid.

S. S. BREMEN AND MAIN ON FIRE NEAR THE HOBOKEN DOCKS.



S. S. SAALE RAISED AND RETURNED TO HER DOCK AFTER THE FIRE.

Many also perished by jumping from the docks and ships into the water, and drowning amid the confusion which prevailed.

Regarding attempts to control or subdue the fire, the city fireboats were on hand and did what they could, but were utterly inadequate to check or in any way control the situation.

From the docks an alarm was sent in, but so rapid was the spread of the flames that the local fire department was unable to more than afford some protection to neighboring property.

There is evidence that the docks were equipped with fire apparatus considered ample for any circumstances likely to arise, and that a hose located only some 30 ft. from the outbreak of the fire was immediately brought into use, while other apparatus was brought forward into action as rapidly as possible. Even so, it shows how utterly inadequate was this provision for the circumstance which arose, or perhaps we should say, how utterly beyond anything which might be expected were the especial circumstances of the fire.

As to the final fate of the ships, the *Saale,* drifting down the river, finally grounded on the Jersey flats and burned out. Since then she has been pumped out, the work of removing the dead has been completed, and the ship has been disinfected and towed back to the burned docks.

Similar work on the *Bremen* and *Main* is also under way, and when completed a thorough examination can alone determine the next steps to be taken. On all three of the ships, except possibly the *Main,* repairs seem to be practicable, and we may hope that in spite of the terrible experiences of the fire, further years of usefulness yet remain to these ships.

VIEW OF THE BURNED PIERS.

Loss of S. S. Georges Croise.—A grave charge of cowardice has been made against Captain Francisco Catrain and the officers of the steamship *Georges Croise,* which recently sank at the mouth of the River Ozama, Santo Domingo. The vessel was an old steamer of about 355 gross tons, engaged in trade between Santo Domingo and Cuban ports. The vessel came out of the harbor at about the time that the S. S. *New York,* of the Clyde Line, had arrived to pass in. When the *Georges Croise* crossed the bar she was seen to list suddenly to starboard, and in less than fifteen minutes she sank in deep water. Boats from the *New York* reached the sinking vessel in time to take off the passengers, most of whom were Cuban refugees returning to their homes in Santiago. The captain and officers of the sinking vessel had already got away in one of the boats, leaving the passengers to take care of themselves. After the rescue, when the *New York* reached her pier, she was visited by President Jiminez, who publicly thanked Captain Proctor and his crew.

CORRESPONDENCE DEPARTMENT.

Editor of Marine Engineering:

Sir: I am constrained to write to you concerning my improved form of marine engine or Bovoid Motor—my draftsman flippantly calls it the "beefsteak engine"—as I noticed that the liquid air and electric experts are making such impossible claims, as you very properly point out in your last issue.

I believe that the great mistake which investigators have made in the past has been the attacking of the problem of energy transformation from the inorganic side of the question. The forces in organic nature are not realized, even in this age of science, to anything like the extent they merit. Let anyone take a walk along the countryside and note the manifestations everywhere in the peaceful landscape, of the enormous inanimate non-returnable forces which, in synchronism with the inter-planetary fluctuating pressures, nourish the fibro-vascular elements of the leafy shoot, and project the tall timbers to an altitude far above the height of puny man. Even the city dweller will note the weighty flagstone moved from its bed by the tiny umbrageous shrub, which by the infiltration of a chance seed has tapped the nourishment of earth.

But to leave the domain of philosophical science for the practical sphere of marine construction. I have succeeded in adapting the humble beast of the field to a work more useful, though not less vital, perhaps, than the sustenance of the crew and passengers of a ship. My attention was first drawn to the subject on a transatlantic trip, in noting the great wastefulness in the culinary department. Hundreds of pounds of meat, representing millions of thermal digits were cast overboard in both the cooked and raw conditions while at the same time the vessel was carrying hundreds of tons of inert coal for use in the monstrously unwieldy and dangerous boilers. I cannot give you more than a brief outline of my process, for as yet patent rights have not been secured, and the psychological moment for the exploitation of my apparatus has not arrived, the interests of civilized peoples being now concentrated on self destruction, witness the Boer and Chinese wars.

But to resume. It will be conceded by every scientist that 1 lb. of beef will sustain one man for 24 hours, with the necessary water. Now, allowing double this amount, and assuming eight men equal to one horse (a liberal allowance), we get for 20,000 I.H.P. a total daily consumption of less than 150 tons of beef. Compare this with coal, which, under favorable conditions, would call for more than 300 tons dead weight for the same horse power. Thus at once we get rid of fifty per cent of the present weight and bulk in the bunkers. Then for the present enormous boilers and contained water we substitute my "macerator." This is fitted with a hopper into which beef is deposited in suitably sized pieces. In a large vessel a buzz saw would be used to reduce the frozen carcases to the proper dimensions. In this macerator the latent energy of the meat is extracted and the refuse muscular structure is separated out. I found enormous difficulty in perfecting the "eviction valve" in this machine, whereby the refuse matter is thrown out and the energy—"rotian" I have termed it—safely housed. So great is the etheric intensity of the latter that were it permitted to escape into the interior of the ship it would instantly combine with the spiegeleisen in the hull plating and by increasing atomic attrition lead to the speedy dismemberment of the vessel. Long experimentation was also necessary before there was any real progress in transforming this rotian into useful work. It was here indeed that the well known economic law discovered by the engineers of Ancient Rome, *Ex Nihil nihilum, in nihilum nil posse reverti,* was availed of. The refuse which I term "epistrophe" as it is used again, is saturated with the oils of the fat (also separated out in the macerator) and compressed into briquettes which are utilized to warm up and vitalize the rotian in the "flatus tank" or "equalizer," which is connected in series with the macerator.

It is important here to get two results, a sufficient density of rotian combined with a proper temperature, permitting a subsequent extension (not expansion as in the steam engine) along an adiaphorus curve. By an ingenious combination of the differential thermopile and the integrating bolometer in one instrument, the correct point of liberation is read or registered, and the rotian automatically passes on to the Bovoid Motor, or, as my assistant is pleased to term it, the "Beefsteak Engine." In this engine by actual dynamometric measurement I have secured a pressure of 500 ft. tons per sq. in. of cross sectional crank pin area, at a rate of consumption of beef at the macerator, not exceeding 60 lb. per hour.

My engine is vastly more compact than the steam engine, and by getting rid of all vibratory disturbances on account of the synchronism of the piston movements with inter-planetary pressure fluctuations by barometric regulation, I can decrease engine room weights materially. I use the ordinary method of screw propulsion, and make no claim whatever to any original investigations in this direction, contenting myself with the more sublime problem of co-ordinating the elemental forces that nature has freely given us in one effective direction, viz., the propulsion of ships. I should have been much further advanced with my work but for an explosion of gas in my laboratory, which wrecked all my apparatus, and prevented a preliminary trial during the Spanish war.

Yours respectfully,

Phineas Lambert.

James Gordon Bennett's Yacht.—Work on the hull of the new steam yacht for James Gordon Bennett, from Watson designs, is well advanced at Denny's yard at Dumbarton, Scotland. The design of this vessel is very peculiar, calling for a straight stem, great overhang at the stern, straight funnel and single pole mast abaft the funnel. The vessel has been the subject of a number of tank experiments at the Dumbarton yard, and it is expected that she will be very speedy. Not less than 18 knots is looked for on the trial trip. The interior arrangements are rather unusual in that the number of separate rooms will be small and the dimensions of each large.

It is announced that the New York Shipbuilding Co., with yards at Camden, N. J., has secured two important contracts.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—FIREROOM—III.

BY DR. WILLIAM FREDERICK DURAND.

ROUTINE AND MANAGEMENT.

Sweeping Tubes.—In addition to the cleaning of fires, the tubes will require cleaning from time to time, dependent on the character of the coal and other circumstances. With soft coal and moderate draft they will soon become partly filled with soot and ashes, thus choking the draft still further, and preventing the transfer of heat to the water through the metal of the tube.

To prepare for sweeping tubes the draft is checked, ash-pit doors put up, furnace doors opened and front connection doors raised. Care should be taken to wait until the fire is burned partly down before doing this, so that the circulation of air through the grates may not be shut off while the fires are too heavy, thus endangering the grate bars. For cleaning the tubes the ordinary wire tube brush may be used. This consists of a mounting carrying wire bristles and fitted usually with a jointed handle by means of which it is pushed and pulled through the tubes, thus cleaning out the soot and ashes collected there. A more modern method consists in blowing through the tubes with a steam jet. The mounting of this appliance consists of a flange or conical ring fitting closely to the end of the tube and provided with a steam nozzle directed along the center of the tube. A handle is provided for holding and guiding the apparatus, and steam is led to it by means of a flexible hose. By this means the ashes and soot are driven out of the tubes into the combustion chamber. By still another form of apparatus the jet is not directed into the tube but across the front end producing a suction, and thus drawing the ashes and soot to the front connection and discharging them up the funnel.

The operation of sweeping tubes is one that is necessary to maintain the continued efficient operation of the boiler, but it must not be forgotten that it involves a serious disturbance to the draft of the whole battery, that the chilling of the heating surfaces and interruption to the regular routine are hard on the boiler itself, and that hence, it should only be done when necessary and then as quickly as possible.

Stopping Suddenly.—With everything going along its regular schedule, suppose that the engine is suddenly stopped. The dispositions to be taken will depend on whether the stoppage is momentary or whether it is expected to last for some time. Here again the caution regarding a sudden change in the conditions must be kept in mind. If the stop is but momentary it will probably be sufficient to shut off the draft, close the dampers and put on the feed strong, standing by to ease open the safety valves in case the pressure rises too near the point of blowing off. If the stop is to be longer it may be necessary to still further check the fires by putting up the ash pit doors and opening the furnace doors. Caution must be exercised in thus checking the flow of air through the grates lest there be danger of overheating the bars, or even of bringing them down into the ash pit. Of these various steps for checking the fires the opening of the furnace doors and the sudden chilling of the heating surfaces is the most objectionable and should not be resorted to unless necessary. As an additional means the fires may be freshly coaled, especially with dampened coal. This will check the formation of steam and provide fuel for bringing them into good condition for the next start. A period of stoppage like this may also be taken advantage of to clean such fires as may be in need of it.

In addition to checking the formation of steam, that which is formed may often be used in a variety of ways. If evaporators are provided it may be turned on to them and thus go toward increasing the store of fresh feed water. The bilge pump may also be put on strong, and if its exhaust is saved there will be no loss of fresh water. In some cases with independent air and circulating pumps a bleeder is provided for taking the steam direct from the main steam pipe to the condenser. Here it is condensed and then sent by the feed pumps back to the boilers, thus avoiding blowing off at the safety valves and the loss of fresh water, and allowing the fires to be gradually reduced to the condition desired for the period of stoppage.

Here again in all of these operations general principles are often worth more than a multitude of minor directions. These principles are (1) *Sudden* chilling of the boiler heating surfaces must be avoided as far as possible. (2) Fresh water in the form of steam should not be wasted, and (3) Care must be taken not to allow the grate bars to melt down.

So far as relates to the general securing of the machinery and gear in the fire-room, the hints given in connection with getting under way will be a sufficient guide in reversing the process.

Supplementary Hints Relating to Water Tube Boilers.—In water tube boilers the circulation is usually more nearly natural than in fire tube boilers, and circulating devices are not, therefore, required. Steam may be raised in such boilers in from twenty minutes to one hour, depending on the type, character of the draft, etc. With this type of boiler it is especially necessary that for the best results the firing be light, often and regular, and that the fires be kept as nearly as possible in a uniform condition. It is also necessary that the feed be regular, and the water must be carefully watched, since from the small amount contained, any lack of feed in a given boiler will be followed by rapid lowering of the level, and by a rapidly increasing likelihood of danger to the tubes. In water tube boilers it is especially necessary that nothing but fresh water be used as feed, and great care must be taken to keep the condenser tight and the fresh water make up ample in quantity.

The tubes of water-tube boilers become coated with soot and ashes on the outer or fire side, and it is usually a very difficult matter to satisfactorily clean them without the use of a steam jet. In continued steaming for long periods, it will usually be found necessary from time to time to let the fires die down somewhat and to use what methods are available for blowing off and dislodging the soot from the tubes.

Coming Into Port.—When coming into port notice will usually be given some hours in advance, so that the fires may be worked into a condition in accordance with their expected disposition after arrival. If they are to be drawn and the boilers opened up for examination and

repairs, they will be allowed to burn down as low as possible so as to use no more fuel than necessary, and to leave as small an amount as possible to finally haul, while at the same time sufficient steam must be maintained to bring the ship safely to her anchorage or dock. If, on the other hand, the fires are to be banked, they will not be allowed to burn so low. It may be recommended to bank fires on the front of the grates, as in such case the air is heated as soon as it enters the furnace and the boiler is kept at a more nearly even temperature than if they are banked at the back of the grate. As the fires are banked they should be cleaned and enough fresh coal put on to hold them in the condition desired. If the fires are properly managed there will be little extra steam after the engines are stopped, and this may be readily disposed of by means of the evaporator, bilge pump, bleeder, safety valve, etc. Loss of fresh water at this time is of course less objectionable than when on the voyage, and if desired the steam may all be blown off through the safety valves. Many engineers, however, object to using the safety valves and escape pipe for this purpose except as a last resort, and prefer other means as mentioned. In passenger vessels the noise occasioned is usually considered objectionable, though to obviate this a muffler is frequently fitted in the escape pipe.

If the boilers are to be opened fires are allowed to die out or are hauled immediately. If time permits the former plan is preferable as the change in the condition of the boiler is more gradual. When the fires are finally hauled and the furnaces, back connections and tubes cleaned out, the ashes, soot and clinker are wet down and piled away until they can be disposed of to the ash barge, as few harbor regulations allow the dumping of ashes overboard. In wetting down the fires after they are hauled out on the fire room floor, or in wetting down ashes at any time, care should be taken not to wet the fronts of the boilers or the mouths of the ash pits. The local chilling will not improve the quality of the boiler and furnace plates, and the alternate wetting and drying will increase the opportunities for surface corrosion. For the same reason damp ashes should never be piled up in contact with the boiler or furnace plates, as in many instances serious corrosion has resulted from a neglect of this precaution.

The fires being burned out or hauled, some engineers proceed to blow the boilers down immediately. This plan, however, cannot be recommended and should not be adopted unless the time available for examination and repairs is so short as to make it absolutely necessary. It is far better to let the steam condense and the water gradually cool, and then draw it out by means of a pump, or in some cases run it into the bilge. In this way the boiler cools more gradually and the structure is left in better condition, while on the water side the scale and incrustation will usually be made softer and more easily removed than when the boiler is blown down with steam on.

It is estimated that the mercantile and naval tonnage now building in the United States represents an aggregate value of $69,000,000, exclusive of armor and guns for naval vessels. This represents nearly one dollar per *capita* for the population of the United States.

ENGINEERS' DICTIONARY.—XXX.

Oil.—Material used for lubricating the moving parts of machinery. For the various rubbing surfaces and turning joints, except within the cylinder, olive oil, castor oil, and the lubricating grades of mineral oil are used. Olive oil when pure is a most excellent lubricant, especially for machinery of moderate or light weight, but it is liable to adulteration by peanut oil or other oils of an inferior quality. For the internal surfaces of steam cylinders, nothing but the best mineral oil must be used. The grade commonly employed is known as *cylinder oil,* and is heavy and viscid at ordinary temperatures, becoming quite fluid, however, at the temperature of the steam.

Oil Cup.—A cup for holding oil, and from which it is fed to the point where it is required.

Oil Pipe.—A pipe for conveying oil from a source of supply to a more or less distant point where it is delivered to a bearing surface.

Packing.—In general, any material used for making a steam or water-tight joint. As regards the packing, joints may be divided into two classes as follows: (1) Fixed joints as those between a cylinder or valve chest cover and flange, and (2) sliding or slip joints, as those between a piston-rod or valve-stem and the stuffing box.

For stationary joints a great variety of packings are in use, the difference depending to some extent upon the temperature to which the joint is to be subjected. Thus for joints to stand high temperature as with boiler manholes, cylinder heads, etc., sheet asbestos, either plain or in combination with other materials, is used. There are also various kinds of packing in which rubber in one form or another is used, either in combination with some fibrous material as sheet canvas, or as a constituent of some form of compound. The tendency of rubber by itself is to grow dry, hard and brittle, especially under the action of heat, and the purpose of the modern forms of rubber compound is to avoid this tendency, at the same time retaining its elasticity and joint-making qualities. For joints not subject to a high temperature, similar forms of packing are used, though with a greater proportion of rubber if desired. The strip or ring of packing which is cut out and fitted for the joint is called a *gasket.* In addition to such materials, joints are also made with gaskets of corrugated sheet copper, or of plain copper wire. For high pressures such gaskets have proved quite successful. The soft copper is expanded between the harder metals of the flanges, and spreads, filling the surfaces where it touches, thus making a tight joint.

For sliding joints the greatest variety of packings is also in use. They may be divided broadly, however, into the two classes, fibrous and metallic. The fibrous packings are made of the same material as the sheet packings above described, but are either round, square, or triangular in section. For use they are cut to such lengths as may be necessary, and placed in the stuffing box in layers or turns, the joints between the ends being shifted so as not to come one above another. For description of metallic packings see under that head.

The Russian cruiser Variag is reported to have made a speed of 24.22 knots on her preliminary trial on July 25.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS.

BY PROF. C. W. MAC CORD.

We proceed now to consider a second method of making drawings which in one view not only exhibit the three dimensions, but at the same time show certain systems of lines in their true lengths, so that all may be measured by the same scale. The principle of this new process will be clear by the aid of Fig. 55, in which

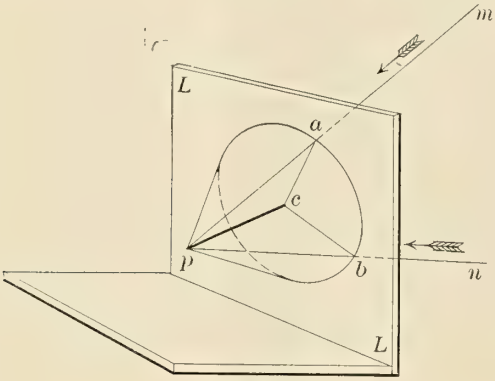


FIG. 55.

L L is a vertical glass plate representing the picture plane. Let *c* be a point in this plane, and *c p* a line perpendicular to it. Also let *p m* represent a visual ray, making an angle of 45° with the plane *L L*, and piercing it at *a;* then *a c* is the projection of *p c* upon the picture plane—and it is equal to *p c,* because the angles *c a p, c p a,* are each equal to 45°.

Now imagine the eye to be at an infinite distance in the direction *p m;* then all the visual rays will be parallel, and all lines perpendicular to the picture plane will be represented upon that plane by lines of their actual length, and parallel to *a c.*

The fact that the projection *c a* is equal to the line

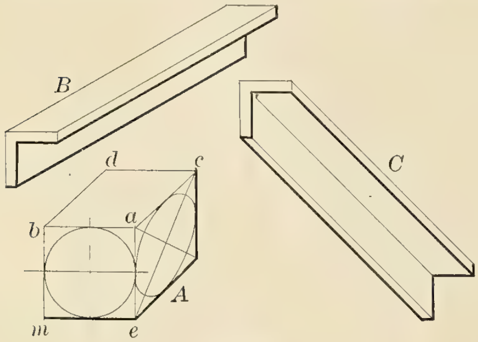


FIG. 56.

c p, depends upon the condition that the projecting lines make angles of 45° with the picture plane; but the *direction* of the projection depends upon that of the visual ray. Thus, supposing the eye to be still at an infinite distance, but in the direction *p n,* the projection will still be equal to *c p,* but it will have the direction *c b;* in short, if *c p* be the axis of a cone of revolution whose angle at the vertex *p* is 90°, the projecting lines may be parallel to any element of that cone.

Any line which lies in the picture plane is, of course, its own projection; and in representing, for instance, a cube, as at *A* in Fig. 56, we may assume its nearer face to lie in that plane, thus appearing as a square of its true size. From what precedes it follows at once that the edges perpendicular to *L L* may be represented by lines of their true length, but having any direction at pleasure; we can therefore show in addition to the front or nearer face, either the right face or the left, the upper or the lower, as may best suit our purpose. And either of these two faces may be made the more conspicuous by proper selection of the angles, as shown by the representations *B* and *C,* which are merely different drawings of the same angle iron upon the same system.

And this is a system of true *oblique projections;* the projecting lines are all parallel, since the eye is infinitely remote; but instead of being perpendicular to the picture plane they make with it a given angle less than 90°—which has so far been limited to the arbitrary value of 45°. This mode of representation is obviously more flexible than the isometric system, by reason of the freedom of choice as to the direction of the receding lines. And it is always as easily constructed as the other; and in many cases more so, owing to the fact that what-

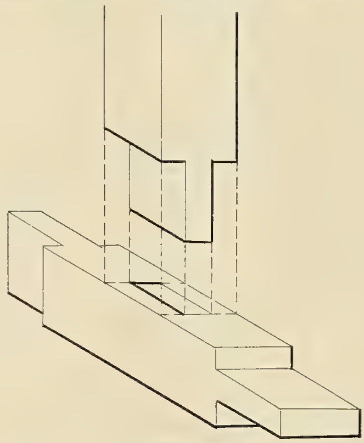


FIG. 57.

ever is parallel to the paper is seen in its true form and size; thus the circle inscribed in the nearer face of the cube in Fig. 56 is more readily drawn than the ellipse which represents a circle in any isometric plane, and the circumstance that the right angles in the front face and all planes parallel to it are represented by right angles, unquestionably facilitates the execution. Nevertheless there is an apparent distortion, just as there is in the application of isometry, but of a different kind. For the purpose of comparison, we have in the following figures drawn in this manner some of the objects represented in the preceding article, of the same dimensions and on the same scale. Thus the reader may judge for himself of the relative advantages of the two systems by comparing Fig. 57 with Fig. 45; Fig. 58 with Fig. 46; Fig. 59 with Fig. 52, and Fig. 60 with Fig. 54.

This method of representation is known as "Cavalier Projection," and also as "Cabinet Projection," and is exceedingly convenient in making sketches; in many cases also, drawings thus made, by reason of their showing three sides of an object in one view, are actually more effective—seem more explanatory and easily read, than ordinary plans and elevations, even to those who are familiar with the latter.

The determination of lines which are neither parallel nor perpendicular to the paper, is effected by means of "offsets," very much as in isometric drawing. Thus in Fig. 61 is shown a rectangular prism, surmounted by an irregular wedge. The line $e d$ is parallel to the paper, and being horizontal, is also parallel to $a g$. To locate it, we may set off $a b$ on $a g$, equal to the distance of d from the plane $a m$, then draw $b c$ parallel to $a o$ and equal to the distance of d from the front plane, $a n$, and at c set up the vertical line $c d$, equal to the distance of d above the plane $a l$. Otherwise, we may erect $g h$, equal to $c d$, draw the horizontal line $h k$ equal to the distance of e from the plane $g i$, and then draw $k e$ parallel to $a o$ and equal to $b c$, thus locating the point e.

In regard to the pictorial effect, it will be noted that the apparent distortion varies considerably with the nature of the subject, and it will be found that while in some cases there is little to choose between the two systems, in others one is decidedly preferable to the other. Thus the objects represented in Figs. 57, 58, and 60, appear equally well when drawn in either manner; probably few will question that the isometric drawing of the partly opened box is superior in effect to the Cavalier projection; and the attempt to represent by the latter method the die and matrix shown in Fig. 50 would result in something hardly intelligible. Unfortunately, there is no rule by which to determine which system

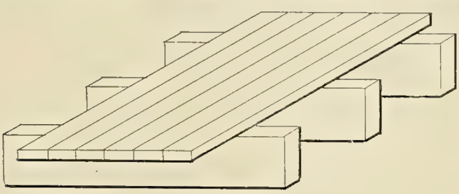


FIG. 58.

to use in any given case; that must be decided by judgment guided by experience and possibly aided by experiment.

In Fig 62, the drawing A, at the left, is a rather peculiar isometric representation of a crank. The isometric axes are $c a$, $c b$, $c d$; of which $c b$ is horizontal. Consequently, $c g$, the longer diagonal of the rhombus circumscribing the isometric circle of the shaft, is vertical. And the peculiarity consists in this, that $o r$, the centre line of the nearer face of the crank, coincides with $c g$. Clearly, $m n$, the major axis of the isometric circle of the shaft, is greater than $c e$ the true diameter: and the result is, that while x, y, and z, the thickness of the web and the lengths of the hubs surrounding the shaft and the crank-pin respectively, are set off in their true lengths because being parallel to $a b$, they are isometric lines; $o r$, the length of the crank, and all lines parallel to it, must be drawn longer than they actually are, in the proportion of $m n$ to $c e$. On the other hand, the breadth of the web at any distance from the centre of the shaft, measured horizontally across as at t, will be less than the true breadth, in the same proportion that $k l$ the minor axis of the isometric circle of the shaft, bears to $c e$ the real diameter.

At B, on the right of Fig. 62, is shown a Cavalier projection of the same crank to the same circle, and while it must be admitted that when instruments are used in making a sketch, this can be made in much less time than the other, yet A presents a much more pleasing appearance, and has a less outrageous apparent distortion. In purely free-hand sketching, probably most persons would take A rather than B as a model, since an ellipse is more easily drawn by the eye than a circle is; and inasmuch as the dimensions would in either case be figured in, no objection could be made to this selection.

For pictorial representation in an accurate drawing, again, there is no question that A is preferable to B, by reason of the less distortion, at least for objects of

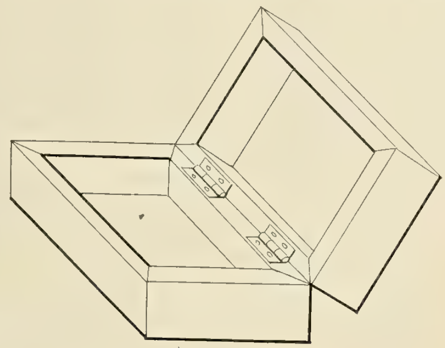


FIG. 59.

this description; but the construction involves the use of two scales for horizontal measurements, of which the units are c e and $k l$, and another for vertical measurements, having m n for its unit.

A reason for this freedom from distortion may possibly be found by reference to the drawing of the cube A, in Fig. 56; where the lines $a c$, $c d$, although really equal to $a b$, appear much longer; and the distortion is excessive, because of a mental recognition of the fact that they would in fact *appear* shorter than $a e$ or $a b$, in looking at a cube from any accessible point of view, because $a c$ and $b d$ are parallel lines receding from the plane $a m$,—being in this case perpendicular to it. In short, the eye recognizes that receding parallels seem to approach each other, and that equal spaces measured upon such lines appear smaller as their distances from the eye increase; this, so far as our senses are concerned, is wholly a matter of observation and experience, although it can be mathematically shown that it should be so.

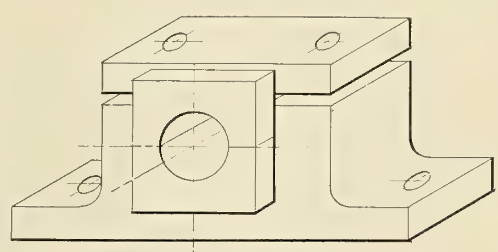


FIG. 60.

Now returning to A in Fig. 62, it is at once recognized that the measurements x, y, z, are in directions perpendicular to the front face of the crank; and being set off in their true length, they appear less in proportion to o r, which is greater than the true length of the crank.

In certain cases at least, then, the distortion of isometric drawings may be reduced for pictorial purposes. And it seems worth while to see what can be done in this direction with oblique projections. Referring to

Fig. 56, it is seen that the drawing of the cube, at *A*, is distorted to an oppressive degree: and so long as it is insisted that the three edges *ab*, *ae*, *ac*, shall all be set off by the same scale, it will be found that no change in the direction of *ac* will diminish that distortion. In order to retain the specific name of "cavalier" projection, it is imperative that these edges shall be drawn of the same length; which requires the projecting lines to make angles of 45° with the picture plane, as shown in Fig. 55. But if in that figure we prolong *cp*, making it, say, twice as long as at present, still retaining the actual lengths of *ca* and *cb* as they are, the effect of this will be that the projecting lines will make with the picture plane an angle greater than 45°; also, *ac* will be the projection of a line twice as long as itself—so that the projection of a line perpendicular to the picture plane, as *ac* or *bd* in Fig. 56, will be only *half* as long as the line itself.

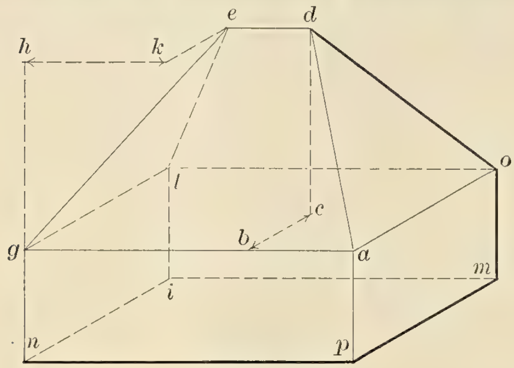


FIG. 61.

A representation of the cube made in this manner is given in Fig. 63; the apparent distortion is obviously very much reduced—so much so, in fact, that for pictorial purposes it may be accepted as a not altogether objectionable substitute for a perspective drawing. In this connection it may be remarked that even an accurately constructed perspective, particularly of a machine, more often than not fails to satisfy the eye and to "look natural." This is less noticeable in the case of architectural subjects, probably because the eye is there usually taken at a very considerable distance from the picture plane. But doubtless one reason, if not the chief one, of the stiff and constrained appearance, is that in the mathematical process of construction the eye is regarded as a single point, and no account is taken of the phenomena of binocular vision. But if the observation be made through a pin-hole placed in precisely the right place, all the distortion disappears, and an almost stereoscopic effect of relief is produced. We have never seen any directions for constructing a perspective drawing to be looked at with two eyes; indeed, it is sufficiently laborious to construct it for a one-eyed man, which may excuse this digression, and the attempt to produce a projection which shall not be too distressingly distorted and out of drawing.

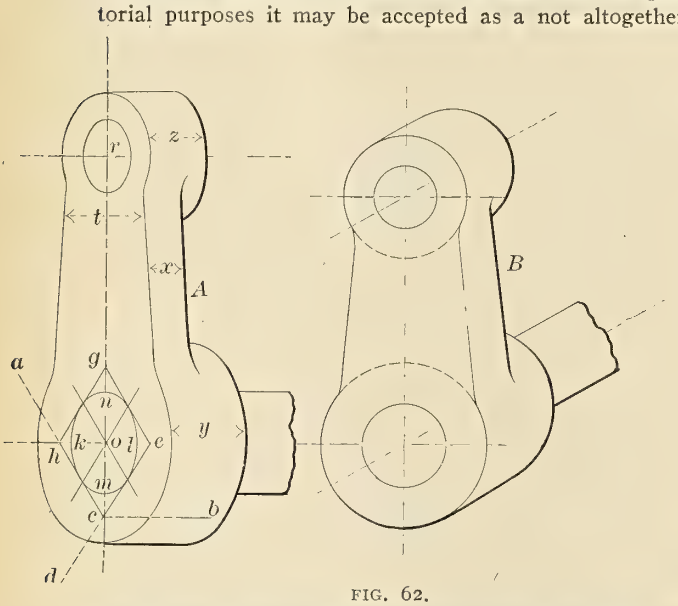


FIG. 62.

Accepting Fig. 63, then, as the result of this attempt, it is to be pointed out that the ellipse representing the circle on the side face of the cube may be constructed in a manner analogous to that employed in Fig. 47, except that as the circumscribing parallelogram is not a rhombus, its diagonals are not perpendicular to each other, and do not coincide with the principal axes of the ellipse. But eight points in it are readily located as in Fig. 47: and the tangents *ba' he*, are also readily determined, recollecting that *ca' ge*, are each equal to one-half of *ca*. The sides of the parallelogram are, of course, tangent to the ellipse at their middle points, as before; and by the aid of these eight points and their tangents, the curve can readily be traced with the free hand accurately enough to enable the operator to ink it in at once by the use of the curved rules or sweeps.

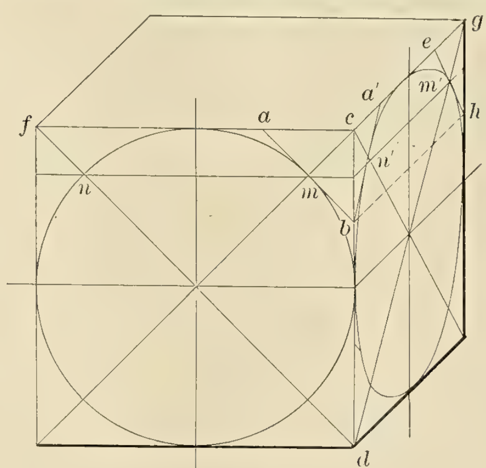


FIG. 63.

The inclination of *cg* to the vertical side *cd*, in Fig. 63, is 45°; but of course any other direction may be given to it; and if for any reason it should be desirable, *cg* may be drawn of one-third, one-fourth, or, indeed, any fraction at pleasure of its true length.

Coast Defense Gun.—There is now under construction at the Watervliet Arsenal, New York, a 16-in. breech loading rifle, which is to be mounted in a Gruson turret at Sandy Hook at the entrance of New York harbor. The gun is nearly 50 ft. long over all, and more than 6 ft. dia. at the breech. The gun, when complete, will weight 126 tons. One of the lathes used in the manufacture of this gun weighs 250 tons, is 135 ft. long, and has a swing of 9 ft.

TECHNICAL PUBLICATIONS.

THE STEAM ENGINE INDICATOR. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. First edition. John Wiley & Sons, New York. Size, 5 by 7 1-2. Pages 153. With many illustrations. Cloth, $1.50.

This book treats the subject of the steam engine indicator in somewhat different form from most of the literature on that subject. It starts with a very complete description of all the modern instruments used in this country, and illustrates each with accurate engravings, showing their internal construction, the individual parts, and methods to assemble them. The adaptation of the instrument to gas engines and ammonia compressors is explained, and valuable hints given on attachments. The method of attaching the piping to the cylinders of the engine as well as the different styles of reducing gear are shown and explained. The errors which are liable to occur in the instrument itself are also pointed out.

Then follows a description of the different styles of planimeters, the principle of their construction and the method of handling them. The next section is devoted to indicator cards, showing the errors which are liable to occur owing to faulty handling of the indicator, also cards taken from simple, compound, and triple expansion engines, gas engines, ammonia compressors, and pumps. The usual tables of areas, properties of saturated steam, etc., are appended.

A great many engineers on vessels, who have not had the advantage of a technical training, are aware of the importance of the indicator, and in many cases are able to decipher an indicator diagram, or at least its most important features. The instrument itself, however, and the handling and attachment of the same, is often a stumbling block. It is often complained that there is no literature on the subject which engineers can readily understand, as most of the books give but little attention to the instrument itself, and then usually some antiquated type, but devote the larger amount of space to abstruse considerations of the results to be obtained from the use of the instrument, into which the reader is frequently unable to follow the author. In this respect Professor Peabody's book will be very welcome both to the practical engineer as well as to the student, as all the computations can be understood by any one having an ordinary school education.

JAHRBUCH DER SCHIFFBAUTECHNISCHEN GESELLSCHAFT (Proceedings of the German Society of Naval Architects and Marine Engineers.) Berlin, Julius Springer. Size, 8 by 10 1-2 in. Pages 435. With many cuts and folding plates.

Naval Architects and Marine Engineers have awaited with interest the appearance of the volume which now lies before us.

When in 1899 it was announced that the German members of these professions had formed a society along the lines of the great parent society, the English Naval Architects, the announcement was received with lively interest, and it was realized that this was but another and logical step in connection with the astonishing strides which Germany has made in shipbuilding in the past decade.

The present volume, the first we trust of a long series, comes fully up to the high expectations which we may have justly formed. Of no small interest is the account given in the introductory pages, of the steps leading up to the organization, lists of members, etc. It appears that the initial list of members numbered 432, gathered from all parts of Germany. The Society is thus seen to start in under the most favorable auspices, and with a list of membership which, both in quality and quantity, may well authorize us to expect much from its future proceedings.

The present volume contains but seven papers, all, however, of high value. The list is as follows:

Modern Submarine Boats..................C. Busley
Application of Wireless Telegraphy to Marine Purposes ....A. Slaby
Steering Apparatus, especially for the latest large ocean liners...............F. L. Middendorf
The Development of the Armor-Plated Ship of the Line...........................Johs Rudloff
Investigations into the Periodic Variations in the Angular Velocity of the Main Shaft..G. Bauer
Resistance of Ships and Estimates of Power. F. L. Middendorf
Strength Computations for Ships......C. Radermacher

The paper on submarine boats is historical and descriptive, and traverses in a thorough manner the development of this form of offensive craft. Their advantages and disadvantages are considered, and the general conclusion is drawn that Germany does well to leave aside the building of boats of such doubtful availability, and to restrict herself to battleships, cruisers, and torpedo craft.

The paper of Dr. Slaby discusses in an interesting manner the possible application of wireless telegraphy for marine purposes, with due note of the limitations under present conditions.

The paper on steering apparatus is of especial note, by reason of the importance of the subject and the completeness with which the ground is covered. The subject is treated first from the historical standpoint, and then the whole ground of modern appliances, especially those used in large ocean steamships, is completely traversed. The paper, which covers 123 pages, is supplemented by a large number of cuts and full-page or folding plates, making as a whole a most valuable and complete presentation of the subject.

The paper by Rudloff is historical and critical, and treats the development of modern armor-clad ships in an interesting and instructive manner.

The paper by Bauer is of great interest and value, as giving much needed information and new light on a subject where little has hitherto been done. The causes for variation in the rate of turning of the main shaft are discussed, and experimental investigations on the subject are described and the results given.

The paper on resistance and power estimates is an important contribution to the subject, seeking, as it does, to develop relations between actual trial results and relatively simple formulæ. A large number of trial results are given as the basis of the discussion,

and these form a collection of data of no small value, independent of their relation to the formulæ under discussion.

The paper on the strength of ships presents the general theory of this subject in a simple manner, and describes methods for determining in the most convenient way the curves of net load, shear, and bending movement. The paper is illustrated with a number of cases, drawn apparently from practice, and serving as interesting examples of such methods and computations.

The volume is well printed and bound, and the illustrations have also received careful treatment. As a whole, the volume is an excellent example of the bookmaker's art, and is worthy of the high character of the material which it contains.

Papers Presented at the Paris International Congress of Naval Architects and Marine Engineers.

Advance copies of most of the papers of the French Congress of Naval Architects and Marine Engineers are now at hand, and furnish an excellent idea of the general character of the programme for the meeting. This Congress is held under the auspices of the "Association Technique Maritime," the French Society of Naval Architects and Marine Engineers, and the efficient secretary of the latter society, M. Hauser, serves as secretary for the Congress.

One of the interesting features of recent international expositions has been the "congresses," or meetings, which have been held for the discussion of matters connected with almost every form of human activity. The possibilities for good in these opportunities for the interchange of thought, purpose, principle, method, etc., especially among different nationalities in the same field of activity, are not likely to be overestimated, and it is a matter of congratulation, both at Chicago in 1893 and at Paris in 1900, that the interests of those concerned with marine construction in all its branches have been so well provided for.

The present Congress brings together representative and leading Naval Architects and Marine Engineers from all countries having maritime interests, and the papers presented and the discussions which they provoke may be properly expected to furnish a series of notable contributions to the literature of the subject.

It will be recalled that the list of papers, so far as in the hands of the secretary at that time, was published in Marine Engineering for May. The list of advance copies contains several additional papers, making a total of thirty-one. These are divided as follows among the different nationalities: French, 16; English, 4; United States, 3; German, 2; Russian, 2; Austrian, 1; Dutch, 1; Italian, 1; Swedish, 1. Compared with the Congress held in Chicago in 1893, the papers are somewhat less numerous, and in the main somewhat shorter, so that unless large additions are made to the present list the proceedings as a whole are not likely to be as bulky as those of the Chicago Congress.

Regarding the papers themselves, they may be properly characterized in the main as of high quality, though there are perhaps few of the very first order of importance.

Among those of especial interest from the theoretical standpoint, mention may be made of the paper by Afonassief on the Resistance of Ships, and of that by Rateau on the Theory of the Screw Propeller.

Of especial practical interest are papers by Moissenet on Tugboat Equipment, by Berling on the Vibrations of the German Cruisers *Hansa* and *Vineta*, and by Croneau on the Electric Equipment of the Cruiser *Rainha Da Amelia*. Of combined theoretical and practical interest are the papers by Doyère on the Test of a River Steamer with Multiple Screws, and by Bertin on the Stability of a Steamer After Bilging of Compartments by Collision at Sea.

Limitations of space prevent detailed reference to these or to many other papers, but the list so far in hand promises a volume of proceedings as a whole which will be of high value to all interested in these subjects, and which in many ways will well serve to show the present actual condition of marine construction, both as a science and as an art.

QUERIES AND ANSWERS.

(*Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.*)

Q.—To settle an argument, will you please say whether "Work and Power" are one and the same, or if there is any difference, what is it? L. R.

Force exerted through space is *work*, and the work is measured by the product of the force and the distance Work, however, is not the same thing as power. The latter contains the *time* element and the unit of power is defined as a certain amount of work done in a unit time. If a force of 40 lb. acts through 30 ft. the amount of work done is 1,200 ft. lb. The amount of power developed will depend altogether upon the time employed. If the time is 1 minute the power will be about 1-27 horse power, while if the time is 1 second the power will be slightly over 2 horse power. When we pay for work by the job we pay for the *work* done; when we pay for work by the day we pay for the *power* exerted or used.

The board which has had under consideration the site for the new $1,000,000 drydock for the Brooklyn Navy Yard has recently completed its work, and it is understood that the Whitney Basin site is the one agreed upon. Actual work on the dock will not be begun for about two months. In the meantime the authorities of the yard are urging the Secretary of the Navy to permit the work to be done by the yard force instead of by contract, as this would furnish so satisfactory a solution to the problem of lack of work for the regular force of employees.

The large American steam yacht *Atalanta*, built for the late Jay Gould, has been sold to the Government of the United States of Colombia, and will be converted into a gunboat. The *Atalanta* was constructed in 1882 at the Cramps yard, and was at the time the largest yacht in the country. It is understood that the interior fittings will be left intact, as she will be used by the higher officials of the Colombian Government, though ready at all times for service as a gunboat.

It is reported on good authority that the Cunard line has ordered two new steamers for its Boston passenger and freight service.

MARINE ENGINEERING.

Vol. 5. NEW YORK, SEPTEMBER, 1900. No. 9

PASSENGER AND FREIGHT STEAMER, "HARTFORD," BUILT FOR THE NEW YORK AND HARTFORD TRANSPORTATION CO.

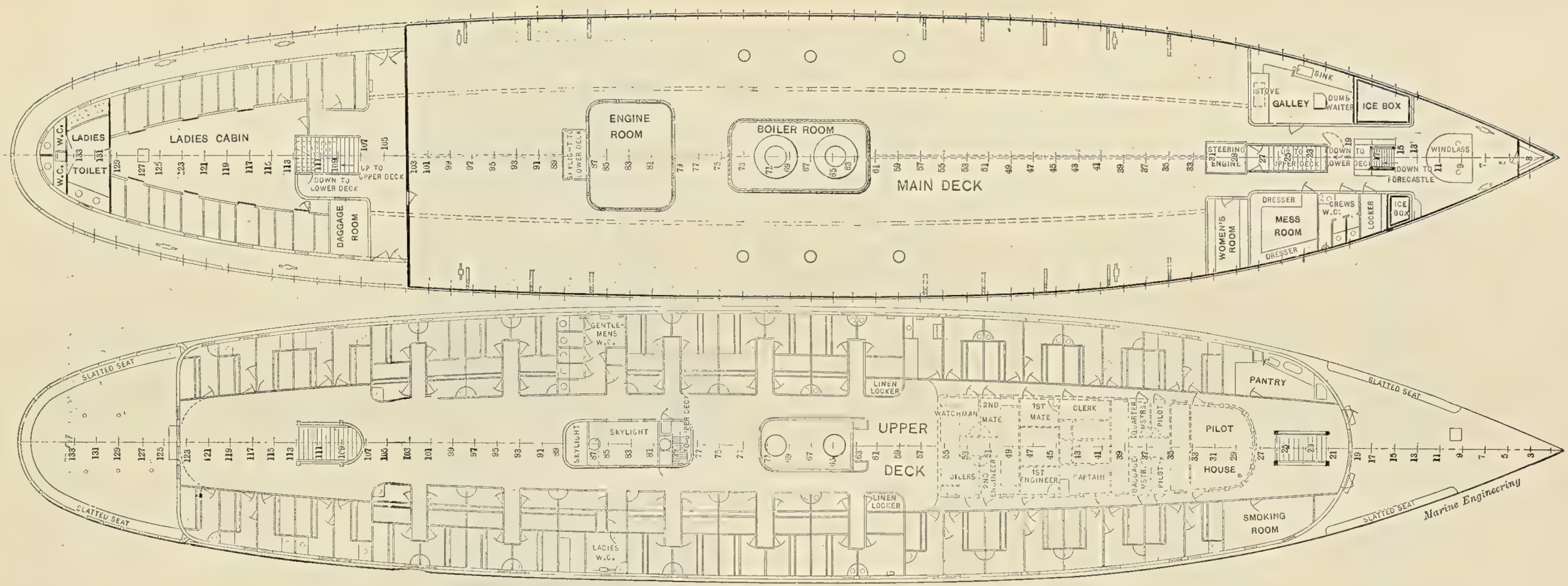
The steamer *Hartford*, built for the New York & Hartford Transportation Company, by the Columbian Iron Works of Baltimore, and now in use carrying passengers and packet freight between New York and Hartford, is a twin screw steel vessel of 1,488 gross registered tons, and having a cargo capacity of about 300 tons of ordinary freight and accommodations for from 250 to 350 passengers. Sleeping accommodations for the former number are provided, but the navigation rules allow as a maximum 350 passengers to be carried on account of the excellent equipment for protection against fire or accident.

The vessel is 253 ft. long over all, with moulded beam of 40 ft., beam inside of fenders 45 ft., beam at load water line 37 ft. 6 in., depth at side 13 ft. 3 in., and mean draft of 8 ft. The lower deck is used for freight cargo, and also for crew accommodations. Upon the main deck are the grand saloon, the dining saloon, the social hall, and 64 staterooms. The pilot house and the captain's and other officers' quarters are on the upper deck. Upon this deck also is a promenade, partially covered by an awning when necessary. Lifeboats, water buckets, and hose are also carried on this deck. The ship's main galley is also located on the upper deck, and is connected with the distributing galley on the main deck by an elevator for carrying the eatables to the dining saloon. The complement of officers and men consists of captain, 2 pilots, 2 mates, 1st and 2d engineers, 3 watchmen and 55 crew. The accommodations for passengers are commodious and well arranged, and the service on the boat is excellent.

STEAMER HARTFORD, OF THE NEW YORK AND HARTFORD TRANSPORTATION CO.

Electric light is supplied by 250 16 C. P. incandescent lamps, of which those in the engine and boiler compartments have vapor proof globes. A 6,000 C. P. searchlight, of Carlisle & Finch's make, is also fitted, together with electric side and headlights.

When in the river the steering is done by watching the shore rather than by compass, and in case of fog it is found that the glare of the headlight renders it impossible to see the shores of the river, and that navigation is thus made very difficult. To provide for



GENERAL ARRANGEMENT AND ACCOMMODATION PLANS OF STEAMER HARTFORD.

such conditions the headlight is so arranged that it may be cut out of the circuit by the officer on the bridge or from the pilot house.

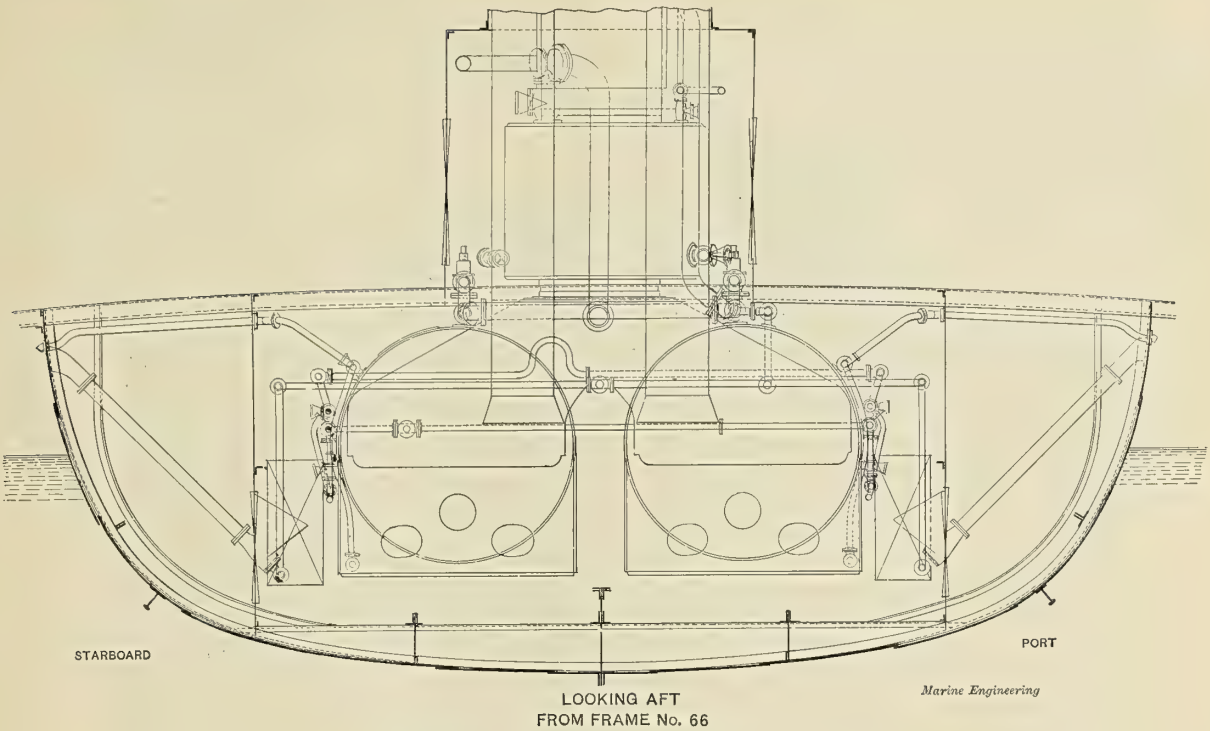
The incandescent lights are divided into twenty-five circuits of ten lights each, each circuit having a separate fuse at the switchboard in the engine room, so that the engineer can replace a burnt out fuse without leaving his station. The current is supplied to the electric lights by a 15 K. W. generating set located between the main engine shafts at the after end of the lower engine room. The dynamo is of the Eddy type, and is run by a "New York safety" engine.

On the lower deck is a Hyde steam windlass for hoisting the anchors and for operating the capstans on the upper deck. The steering engine is placed on the lower deck directly beneath the pilot house and the operating shaft leads from the engine up to the trickstand in the pilot house, while in addition to the steam steering gear there is a large wooden hand-wheel and wire rope drum located just aft of the trickstand for use in case of accident to the steam gear.

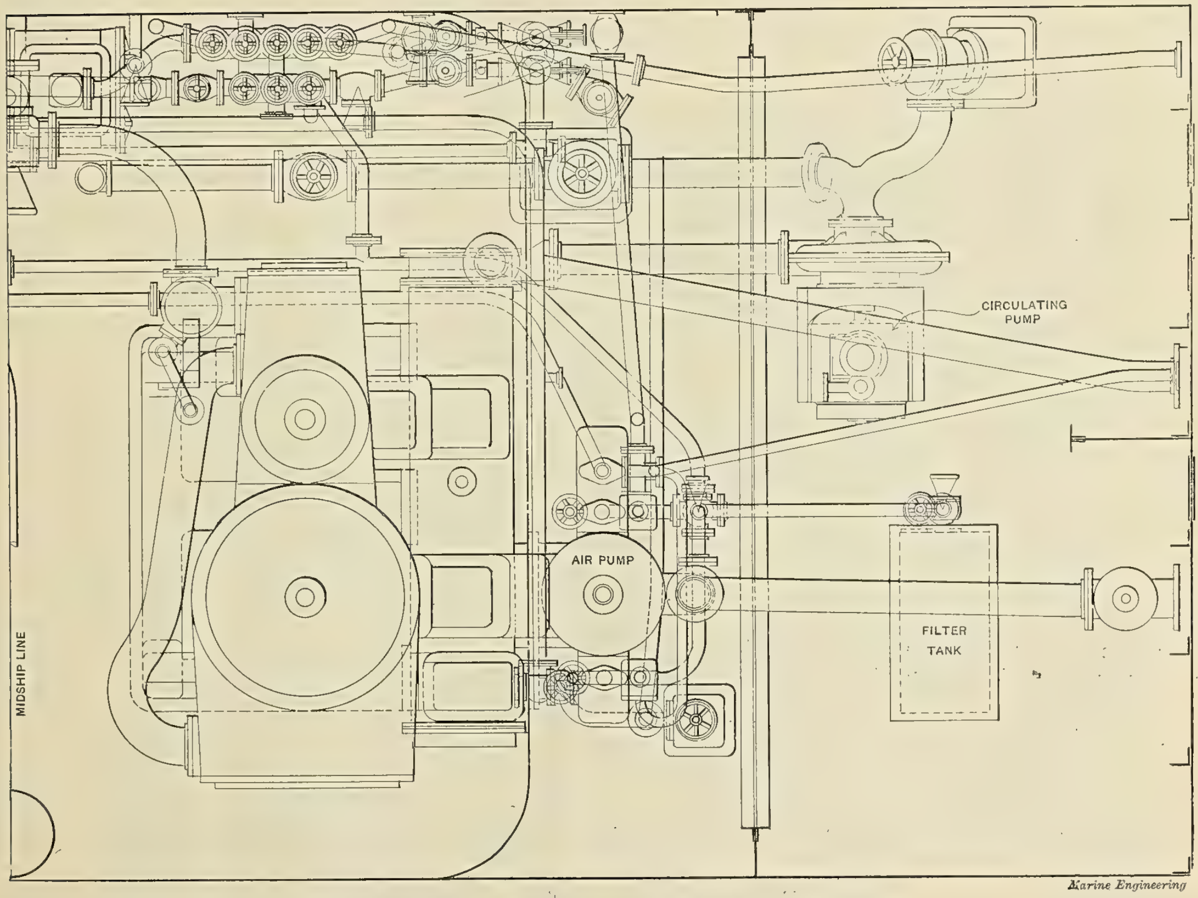
The vessel is propelled by twin screws, driven by two compound vertical condensing engines, having cylinders 20 in. and 40 in. dia. by 28 in. stroke. The high pressure cylinders are placed forward. The main steam pipe from the boilers is 8 1-2 in. dia., of copper, and branches into two 6 in. pipes leading to the throttle valves. The valve gear is of the ordinary Stephenson link type, the high pressure valve being arranged with a Meyer cut-off. The eccentric rods are of forged steel, and have bolt and nut ends. The crosshead guides are of rectangular box section. The upper ends of the connecting rods are forked, and work on forged steel crossheads. Both the upper and lower ends of the rods are fitted with strap connections. The crank shaft is 8 in. dia., forged steel throughout, of the built-up type, with crank pins 8 in. dia. The reverse shafts are on the inboard sides of the engines and are supported by the front columns which are cast iron of rectangular box section. The reverse engines and the handling gear are on the forward inboard column of each engine, the handling gear quadrant supporting also the throttle and reverse gear handles.

At the after end of the engine a worm wheel and worm are fitted for turning the engine over by hand for repairs. Brass pipes for water service are fitted to each main journal and crank pin, and to the crosshead guides. The thrust block is bolted to a continuation of the engine foundation, but not directly to the engine bed plate casting. There are six thrust collars of the ordinary horseshoe type. The line shafting is supported by three spring-bearings.

The condensers are built into the back framing of



SECTIONAL PLAN THROUGH BOILER ROOM.



GENERAL ARRANGEMENT PLAN—STARBOARD ENGINE ROOM.

the engines, and extend the whole length of the bed plate. The condensing water is supplied by a 6 in. centrifugal pump located back of each condenser. The cooling water enters the lower section of the condenser and is ejected from the upper section. The fire pump is located at the forward end of the engine room in the center of the vessel. The air pumps are worked off the low pressure crosshead, together with two feed pumps and a bilge pump for each engine. These four pumps are all bolted to the back of the condenser. The feed water passes through the filter tanks, one on each side of the engine room back of the engine, sponges being used as filtering material. Besides the pumps already mentioned, there is a small sanitary pump in the engine room for supplying water to the various parts of the ship. The water for cooling the bearings is taken out of the water ends of the condensers.

The gratings in the engine room are of wrought iron, having spills 5-8 in. dia, and wrought iron stanchions. Brass pipe is used for hand rails. There are two 24 in. ventilators in the engine room. Over each engine is a 6 in. by 1 in. steel beam, carrying a traveling hoist for lifting parts of the engine.

The boilers are four in number of the water leg type, and are placed with axes fore and aft. The working pressure is 110 lbs. per sq. in. The shells are 8 ft. 6 in. dia. by 14 ft. long. The tubes are 3 1-2 in. dia. by 10 ft. 6 1-4 in. long, No. 11 B. W. G. There are two furnaces to each boiler. The water gauges for the after boilers are in the engine room, those for the forward boilers being in the boiler room. There is also a vertical donkey boiler 40 in. dia. placed on the main deck. There are two 27 in. ventilators in the fireroom. There are two stacks each 4 ft. 2 in. in diameter and about 56 ft. in height above the grates.

When the vessel is in the Sound, the feed water is taken from the hot well and fed into the boilers by the feed pumps. When fresh water is reached in the river, however, feeding is done by injectors which keep the temperature of the feed water satisfactorily high, and the air pumps are allowed to discharge overboard. An ash ejector is fitted on each side of the fireroom supplied with water from the fire pump at 100 lbs. pressure.

Special attention has been given by the builders to the lighting and ventilation of the fireroom and engine room, with the result that in service these compartments are very comfortable. It is partly due to this that the full steam pressure is readily maintained under maximum conditions.

The coal supply is carried in wing bunkers at the ends of the fireroom, having a capacity of 100 tons. The boat is operated under natural draft, although there is provision for a steam jet in the stack. The average working pressure is 95 to 100 lb., and the engines turn at about 110 revolutions per minute with this pressure and 26 in. vacuum. The horse power of the two engines is about 1,000, and the speed of the vessel through the sound averages about fourteen miles per hour.

The first steamboat to navigate the western rivers was the *New Orleans*, built in Pittsburg in 1811, four years after the *Clearmont* had made her successful trial on the Hudson.

EQUIPMENT FOR HANDLING BULK CARGOES RAPIDLY AT GREAT LAKE PORTS.*—III.

BY ARTHUR C. JOHNSON.

The Brown Hoisting and Conveying Machine Co. has built five car dumpers that handle the coal still more gently, but on that account they are necessarily slower in operations. With these machines the coal is dumped from the cars into six buckets carried in a transfer car. Each of these buckets is then lifted by either of two traveling cranes which carries it out over the boat and lowers it into the hatch when the bottom is opened and the bucket drawn away, thus placing the coal very gently and just where wanted. The mechanical arrangements are very ingenious and well executed in securing the complicated motions necessary.

The Hulett Car dumper built by the Webster, Camp and Lane Machine Company, for the Rochester and Pittsburg Coal and Iron Company at Buffalo, works somewhat on the principle of the Brown car dumper, but it is much simplified by using only two buckets—in fact the whole machine is comparatively simple. The clamping mechanism is of the same type as that of the McMyler Machine. The engines for tipping the cradle are located underneath the same, while those for controlling the buckets are located on the platform on top of the machine. The tracks on which the trolleys carrying the buckets run can both be swiveled about a pivotal point by hand to suit any spacing of hatches. The machine can handle regularly 20 cars an hour, but the switching room at Buffalo is so limited that a sufficient supply of cars cannot readily be made accessible to the machine.

A novel design of car dumper is shown in Figs. 17 and 18, built by the Excelsior Iron Works Company for the Erie Coal Transfer Company at Cleveland. This is an exceedingly fast machine, and its operation is very simple. The loaded car is pushed into the cylinder by a locomotive, and the cylinder and car are turned over by a steam cylinder of long stroke, operating through a "two part" rope. The car is supported on its side in turning over by a hydraulic cylinder and clamped on top by a simple device. The machine is well adapted to its peculiar location, where the bank of the river is very high, but the fall of the coal is considerable.

In all the car dumpers the speed depends largely on the switching arrangements and the storage capacity for loaded and empty cars. The three methods in use for bringing the loaded cars into the machine are: 1st. By means of a locomotive. 2nd. By storing the loaded cars on tracks having a down grade into the machine. 3rd. By the use of a haulage mule similar to that shown in Fig. 19. In the last case there is a grade up into the machine. The loaded car pushes the empty car out in all cases.

The car dumpers are also used for fueling vessels, although some of the fuel hatches cannot be reached by the chutes, but most docks handling fuel alone are

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*A paper read before the Civil Engineers' Club of Cleveland and contained in the Journal of the Association of Engineer Societies.

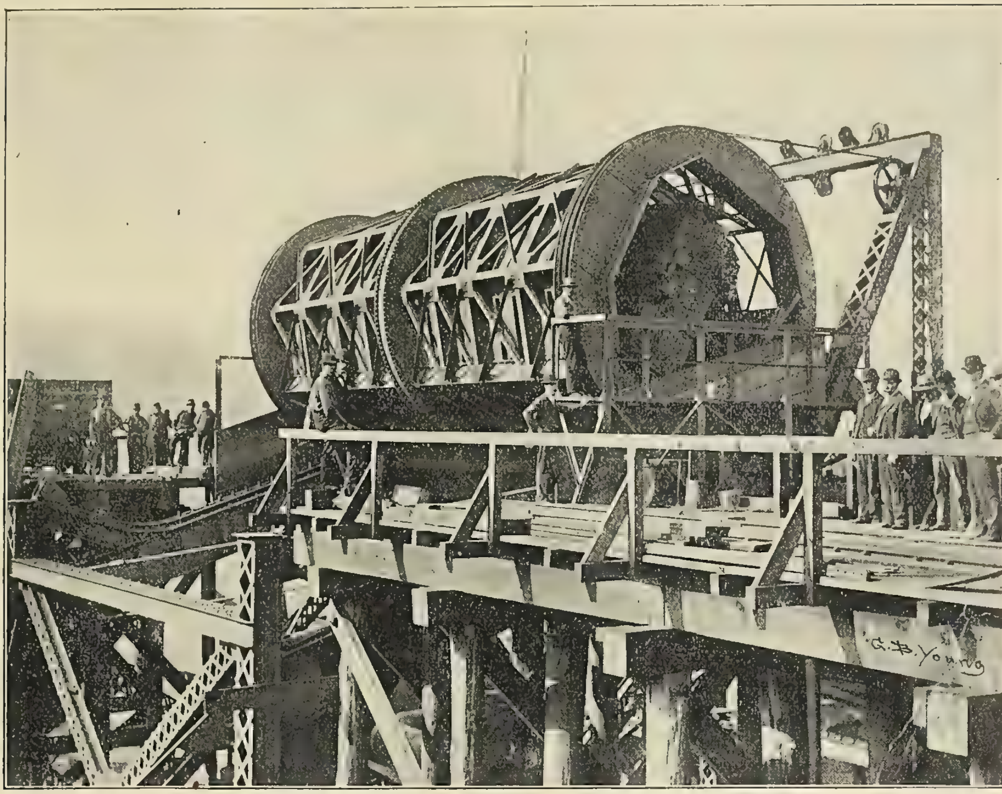


FIG. 17. CAR DUMPER BUILT BY THE EXCELSIOR IRON WORKS CO.

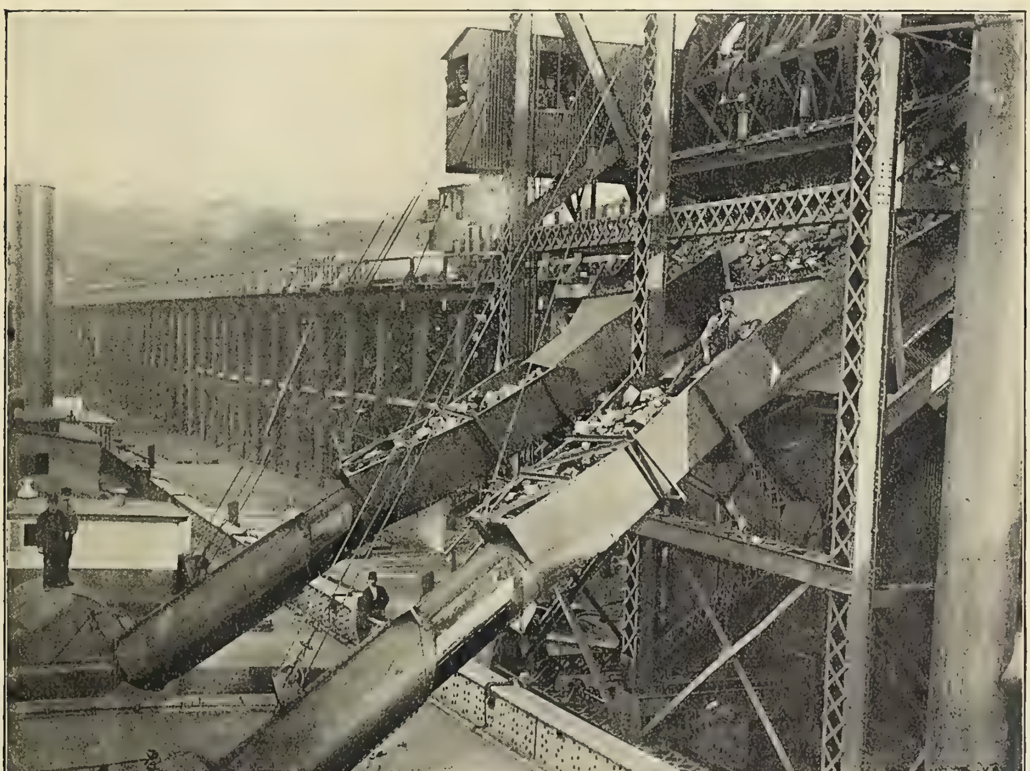


FIG. 18. CAR DUMPER BUILT BY THE EXCELSIOR IRON WORKS CO.

equipped with coal pockets at a sufficient elevation to discharge the coal through chutes into the coal bunkers, the pockets themselves being filled by drop bottom cars from a track carried on top. Fig. 19 shows the equipment of a large fueling dock operated by the Cuddy-Mullen Coal Company at Cleveland, built the friction between the coupler and the front of the mule.

For unloading coal at the Northern ports there are many special machines of the Brown type and others adapted to the special conditions such as storage for railroad re-shipment and wagon delivery in large

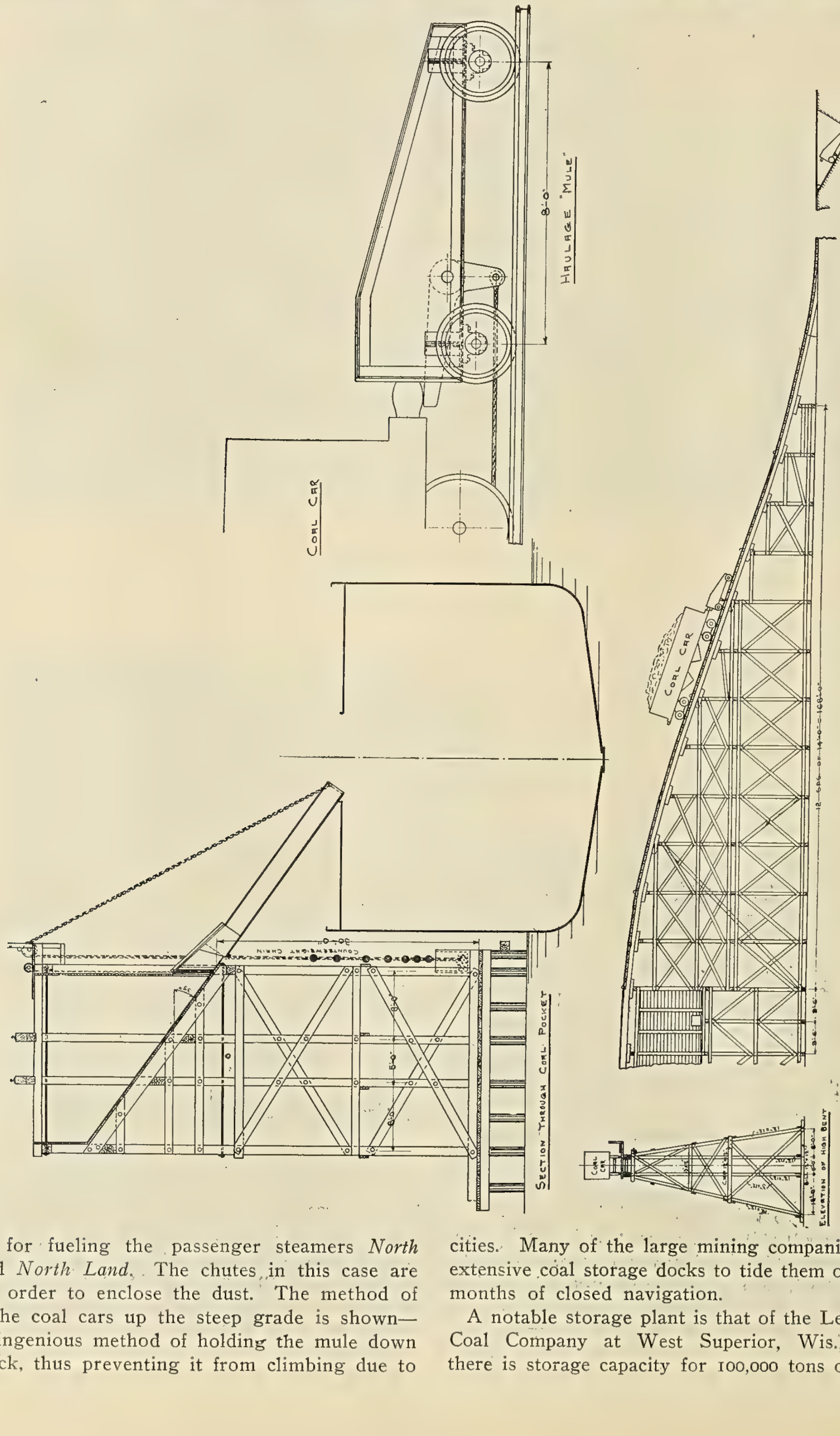


FIG. 19. CUDDY-MULLEN EQUIPMENT FOR FUELING DOCK.

specially for fueling the passenger steamers *North West* and *North Land*. The chutes in this case are round in order to enclose the dust. The method of hauling the coal cars up the steep grade is shown—also the ingenious method of holding the mule down to its track, thus preventing it from climbing due to cities. Many of the large mining companies also have extensive coal storage docks to tide them over the four months of closed navigation.

A notable storage plant is that of the Lehigh Valley Coal Company at West Superior, Wis., on which there is storage capacity for 100,000 tons of anthracite

coal under cover by the Dodge system, and for 90,000 tons of bituminous coal exposed, in piles not over 30 ft. high as precaution against spontaneous combustion. At this plant all the operations of unloading from the boats and storing, and reloading into the cars are performed by machinery.

The most surprising feature in connection with the equipment of docks generally on the lakes—using the word dock in the American sense of pier or landing great improvements in this direction and as examples of recent construction Figs. 20 and 21 are introduced. Fig. 20 is the cross section of a dock built by the Illinois Steel Company at their South Chicago works, which has attracted a great deal of attention from engineers in this country. This dock, which is 1,608 ft. long, was built at the rate of about 15 ft. per day. Fig. 21 is a cross section through the foundation for the McMyler car dumper on the dock of the Pittsburg and

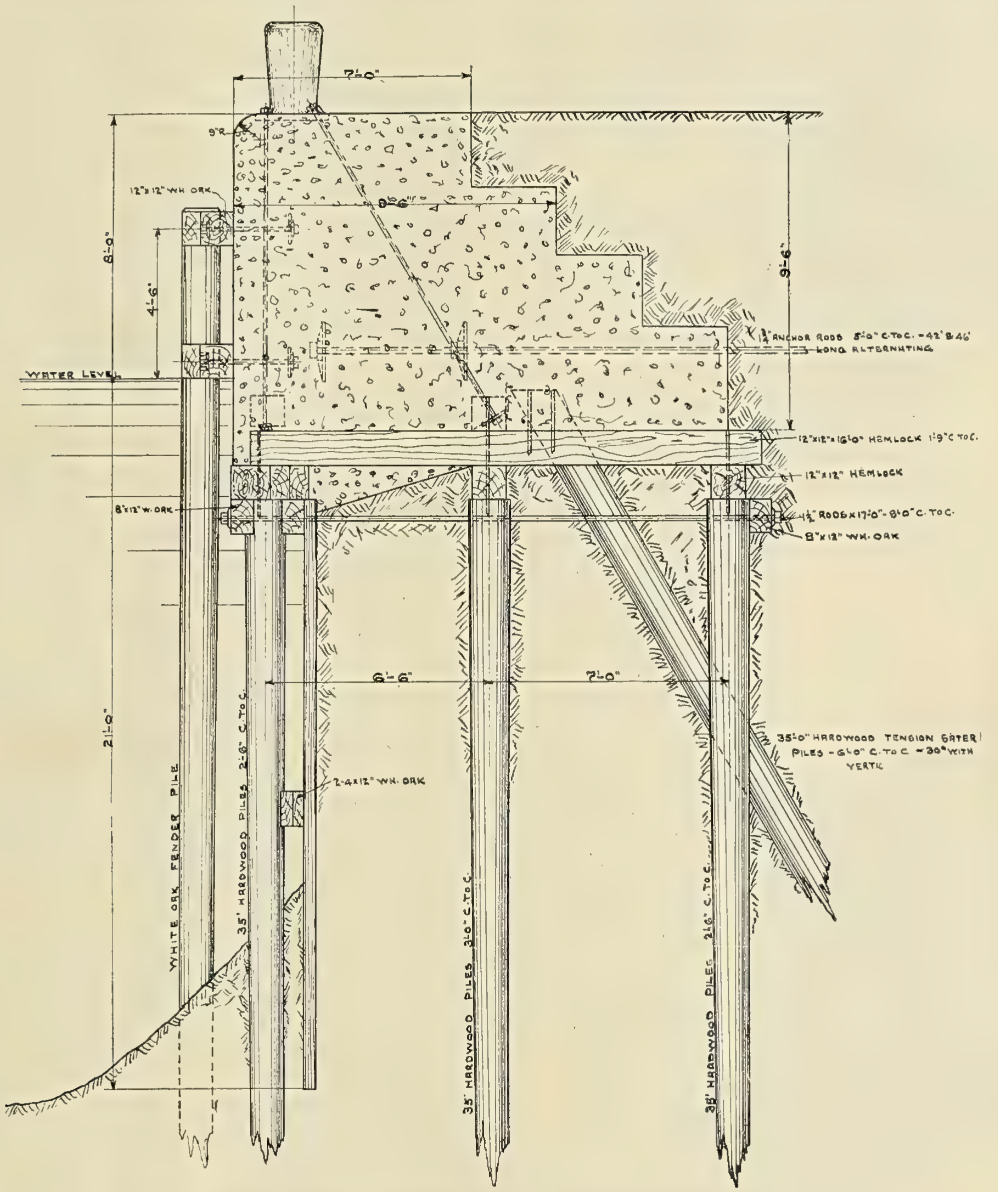


FIG. 20. SECTION OF DOCK BUILT BY THE ILLINOIS STEEL CO.

to which a boat ties—is that such highly improved and expensive machinery should be placed on such poor and entirely inadequate foundations; often merely a few piles, driven in soft mud many feet below the water line, with little or no cross bracing to give them some rigidity. This is probably due to the nervous speed with which a great many dock improvements and extensions have been made.

There is a growing feeling, however, in favor of Conneaut Co., at Conneaut, Ohio. This foundation has proved itself to be immovable.

It will be of interest here to quote from the *Blue Book of American Shipping* that on the Great Lakes there are "The greatest iron mining resources, most rapid cargo handling facilities and the most efficient iron producing plants in the world," together with the statement that "It is possible to take ore from the Mountain Iron Mine and convert into steel ship

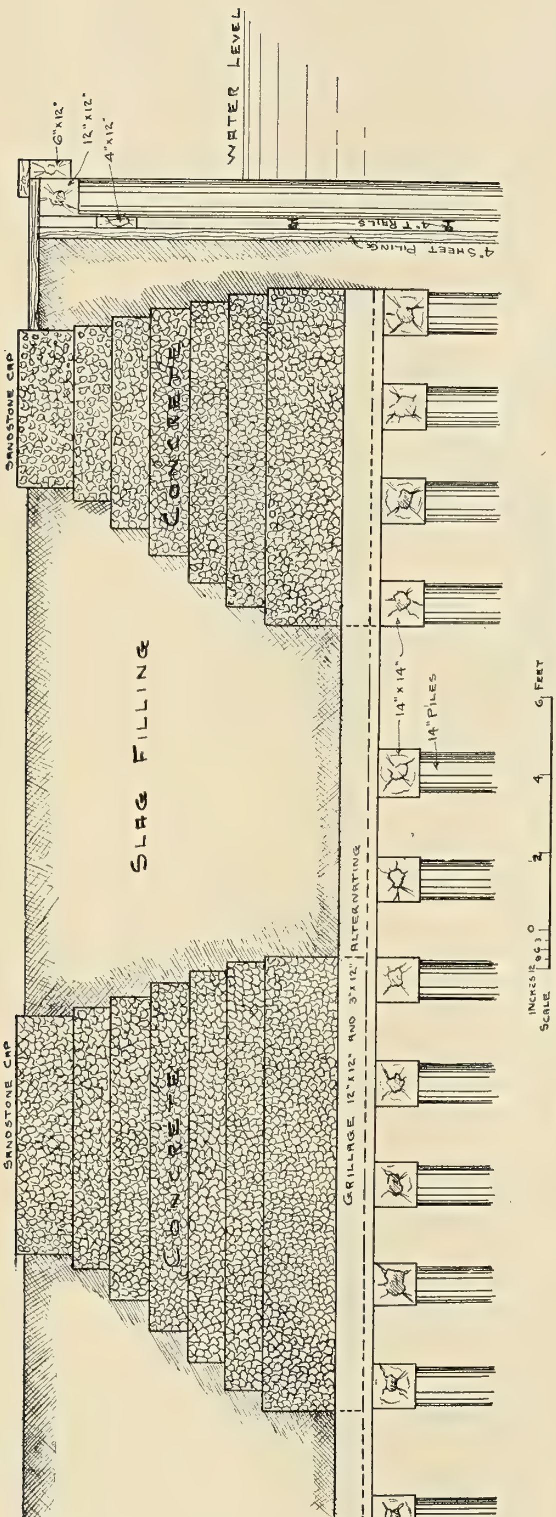


FIG. 21. SECTION THROUGH FOUNDATION FOR McMYLER CAR DUMPER.

plate within ten days." While not becoming responsible for the accuracy of the last statement, quoting from the same source, the explanation is as follows:

"Suppose that on the first day and night of a month 9,000 tons were mined and loaded. The second day at noon this ore could be run onto the Duluth, Mesaba and Northern Railway docks at Duluth, 80 miles from the mine and dumped into pockets. Each of the two docks lack 600 ft. of being 1-2 mile long, and both have capacity for 100,000 tons of ore. In one hour the 9,000 tons could be loaded into a Bessemer steamer and barge, 424 and 366 ft. long respectively. The Bessemer fleet consists of ten steamers and eleven barges, and the carrying capacity of the fleet for one season, between eight and nine months, is over 1,500,000 tons. At one o'clock on the second day the steamer and consort would start on their 890 mile trip. On the sixth day at one o'clock they would arrive at Conneaut, Ohio, the steamer, we will say, going to the McMyler rapid direct-unloading plant and the consort to the Brown plant, both of which are shown in the foregoing illustrations. The seventh day at one o'clock the 9,000 tons of ore would have been taken from the holds of the vessels and loaded into 180 of the 50 ton steel cars, of which the Pittsburg, Bessemer and Lake Erie has 600, and is building 400 more. On the morning of the eighth day these cars would be delivered to the furnace at Bessemer or Duquesne, the four-stack furnace, having annual capacity of 800,000 gross tons of pig iron, at the latter point. The distance from Conneaut to this furnace is about 150 miles.

"On the ninth day at seven o'clock in the morning the ore would have run through the cupola and could be transferred to the Bessemer converter or mixer, and in less than an hour he turned into steel ingots. These ingots could be taken hot to the plate mill and made into ship plate in one hour, or, if from the furnace the iron was made into pigs, about eight hours more would be required to make ingots of the pigs. By the evening of the ninth day this plate would be ready for shipment."

A recent circular from the U. S. Civil Service Commission announces that it is desired to establish an eligible register for the position of Master in the Quartermaster's Department at Large. No scholastic test will be given, but applicants will be graded upon the elements of age, experience, intelligence, character as a workman, and physical qualifications as shown by the information furnished in connection with their formal applications. Candidates may be assured that the ratings will be strictly impartial and based entirely upon the evidence of fitness presented. It will not be necessary for applicants to appear at any place for examination. From the eligibles resulting from this examination certifications will be made to the position of master on the Quartermaster's steamer *General Ayres* at Boston, Mass., at a salary of $110 per month. Persons who desire to compete should at once apply to the secretary of the local board of examiners at Boston, Mass., or to the United States Civil Service Commission, prior to the hour of closing business on October 1.

MATERIALS USED IN THE CONSTRUCTION OF MARINE DYNAMOS AND THEIR ENGINES.

BY ALTON D. ADAMS.

High efficiency, satisfactory operating qualities and reliability are prime requirements for marine dynamos and their engines. Next to these, the most essential characteristics of engines and dynamos for use on ships are small bulk and weight per unit of capacity. How pressing are these last named requirements may be gathered from the fact that in merchant ships a considerable, and in war ships an even larger, per cent of the displacement beyond that of the hull is taken up by the necessary operating machinery.

Almost the entire construction and equipment of ships, except the electric plants, has been the subject of long study and careful experiment, to determine the materials best suited for the purpose, and no reasonable expense has been spared in high class war and merchant vessels to produce the best possible results. In the past it has been the more common practice, on the part of both private ship builders and governments, to accept about what has been offered by dynamo and engine makers, so far as weight and bulk per unit of output are concerned. It is true that some restrictions have been put to the weights of electric generating sets, but these have only been such, in most cases, as good apparatus made for use on land could meet. The growing importance of electric equipment on ships and its application to auxiliary power purposes seems certain to result in more exacting requirements as to weight and bulk.

Good design is able to meet the usual conditions as to efficiency, operating qualities and reliability in dynamos and engines with the structural materials and shapes generally employed, but when bulk and weights are restricted, the kinds and shapes of the materials used are at once involved. The reason for this is found in the fact that structural materials for both engines and dynamos differ widely among themselves in their most important qualities. The characteristics of dynamo materials that have the most important influence on weight and bulk are those of magnetic and electric properties and mechanical strength. Most important of these properties is the magnetic, because of the wide variation among the available materials in this respect, and its large influence on the requirements as to mechanical strength and electrical factors. In the largest and heaviest parts of a dynamo the dimensions necessary to secure desirable magnetic qualities are much in excess of those required for mechanical strength, even where the best available materials are used. It is therefore highly important, where small weight and bulk are necessary, that the magnetic and electric parts of dynamos be of the most suitable materials.

To determine what materials are best suited for use in the several parts of dynamos, the purpose and action of each part should be considered. Taking up first the armature or revolving part, complete, it is found to consist of four essential elements, the shaft, core, windings and commutator. An armature shaft may be forged in one piece with that of its connected engine, but is more usually connected by couplings. In either case there are no requirements to be made as to its magnetic or electric properties, the main necessity being for mechanical strength and stiffness. To insure the desired mechanical properties in a dynamo shaft of the least practicable weight, its material and form should be minutely specified. Dynamo shafts should be forged of hard steel, having about 0.5 per cent of carbon, and should be hollow, as hollow shafts are much lighter than solid ones for given length, dimensions and strength. The largest and heaviest part of an armature is its core, which in practically all cases is built up of wrought iron or very mild steel discs, either of which are suitable for the purposes of light weight when of the proper quality. Armature cores are especially designed to meet magnetic requirements, and their mechanical strength is commonly far beyond any possible demands upon it. Magnetic properties of their iron or steel discs, and the construction of armature cores as to ventilation, materially affect their weights for given capacities, but it is hard to cover these factors save by specifications of the total armature or dynamo weight.

To hold the armature core together and enable it to be assembled independent of the shaft, the discs are mounted on a spider or sleeve and this latter adapted to slide on and off the shaft. This sleeve or spider usually has an extension beyond the armature core at one end and on this extension the commutator is mounted. No electrical or magnetic properties are necessary in the spider, and its important qualities are sufficient strength and stiffness for its work. Cast iron is much used for armature spiders, because it is so readily obtained and easy to machine, but its low strength to resist twisting and shearing make it unfit for the purpose. where small weight per unit of output, for the armature, is desired.

The best material to use for armature sleeves and spiders, for marine use, is soft steel castings, such as can now be had from a large number of foundries. About the only objections to be urged against steel castings for the purpose just named are their somewhat higher first cost both as to the price per pound and the labor for machining them. The additional cost per pound of steel castings is, however, about offset by their smaller weight.

A dynamo commutator consists broadly of two distinct parts, the shell or sleeve and the segments. The shell acts simply as a clamp to hold the segments together, and is usually made of cast iron. When the reduction of weight is an object the commutator shell should be of steel castings, as these give the required strength and stiffness with the least weight. Pure forged or rolled copper is the best and only fit substance for commutator segments, in spite of claims to the contrary by any who wish to sell cheap segments or dynamos with poor commutators. Cast segments are hard to produce in chemically pure copper, their electric conductivity is lower than that of the forged or rolled variety, and they do not resist the wear of the brushes as well. For equal results in operation the cast copper segments make a heavier commutator than forged or rolled stock, and they should never be used on ship dynamos.

Poor ventilation or bad proportions may result in an armature core too heavy for its capacity, and such a core increases the necessary weight of copper wire for winding it. Copper in rods or wire is the only suitable material for armature windings, and those windings

with joints at only the commutator end should be preferred to those having joints at both ends. Some armature cores have a large extension at one end to act as a support for the windings, but this is unnecessary and should be avoided. The magnet cores and poles of dynamos, that is, those parts on which the magnet coils are mounted, form large and very important portions of the machines.

Magnetic properties are chiefly considered in the size and proportions of magnet cores and poles, their mechanical strength usually being far beyond any possible requirements. So great are the differences between materials as to their magnetic properties, that the weight of magnet cores may vary as much as three or four hundred per cent according to the materials selected. Cast iron, wrought iron and steel castings are the materials available for magnet cores and poles. The widely different results as to weight that follow the use of these several metals for magnet cores arise from their different magnetic capacities per unit of sectional area. If the magnetic capacity of wrought iron is taken as unity, per square inch, that of cast iron is about .4, and of steel castings from .8 to 1. In other words, if a wrought iron magnet core with a sectional area of 100 sq. in. will do the work for a certain case, a core of equal capacity of cast iron must have 250 sq. in. and a core of steel casting from 100 to 125 sq. in. sectional area. The length of magnet cores is determined by the amount of wire and energy used in their coils, an increase in the areas of cores increases also the wire necessary for their windings, and usually therefore the length of each core. For the case of cast iron compared with wrought iron, the cast metal being 2.5 times as large in section, and probably 1.5 times as long, at least, is $2.5 \times 1.5 = 3.75$ times as great in bulk and nearly that in weight. Where steel castings are used for magnet cores the increase in weight over that for wrought iron, if any, is obviously small. Great as is the addition of weight by the use of cast iron for magnet cores, it is further augmented by the larger amount of wire necessary for windings. Cast iron was much used at one time for magnet cores, but now steel castings and wrought iron are generally used for the purpose, and should be specified in every case.

The magnet frame or part that serves to mount the magnet cores about an armature, being the largest and frequently the heaviest single part, should be carefully selected, where the reduction of weight is an object. While cast iron magnet cores have been largely abandoned, the cast iron frame is still very common. The purpose of a magnet frame is two-fold, that to mount the magnet cores and fix them to the base and also to furnish magnetic paths between the several cores. Owing to the attractions between the magnet poles and their armature the frame is subject to large mechanical strains, but its section at any point is determined in most cases by the magnetic requirements. In cases where the necessary magnetic capacity can be had with a very small frame section, an excess of mechanical strength and stiffness can be obtained by giving the frame a ribbed or flanged form. Where the weight per unit of output is not material, the use of cast iron for magnet frames may be permitted, but for marine dynamos all frames should be of steel castings, except for some simple shapes where wrought iron is available.

However carefully a dynamo may have been designed to reduce its weight, it has been the too general custom to give an iron foundry a large job on the common base for a dynamo and connected engine. The fact of course is that unnecessary weight in a base is just as objectionable as though it existed in the dynamo proper. A dynamo base is not usually required to have any magnetic properties, but must be stiff and strong. Steel castings are much the most suitable material for dynamo bases where small weight is desired, and should be used to the exclusion of cast iron for this purpose in marine work. The saving in weight by a steel casting instead of a cast iron base is often enough to compensate for the greater cost of the steel.

To rest with restrictions on the weight and materials of dynamos only, for an electric plant on board ship, is to leave the work of specification but one-half done, since the ordinary engine for use on land is even less satisfactory in the matter of weight than is the average dynamo. Vertical engines are the general type best suited for driving ship dynamos, because of the small floor space occupied, the ease of making direct connection to the dynamo, and the high speeds of rotation at which they may be operated. In land engines, and to a large extent those for electric plants on ships, cast iron has long been the most prominent material. Cylinders, piston heads, guides, frames and bases have all found in cast iron their most convenient material. Crank shafts even, in some instances, have been built of much the same material, that is, gun iron, which is simply cast iron of a somewhat higher grade and an increase of strength above the ordinary metal.

Crank shafts for dynamo engines should be forged of hard steel and hollow. In sizes too small to allow hollow forging, the shaft may be forged solid and the interior parts subsequently machined out. Connecting rods should also be of hard steel, but instead of the regular tapered forms rods should be machined into some of the shapes that give required strength with a minimum weight of metal. Hollow piston rods are to be preferred to solid ones in large sizes. Steel castings offer a material saving over cast iron for piston heads and cylinders, in the matter of weight, owing to the strength required in these parts. Cast iron engine frames have in many cases heretofore made up a great part of their weights, as used for driving ship dynamos, and it is in this part of the construction that considerable improvement is possible. A number of vertical engines that have been much used for driving marine dynamos, are of what is known as the enclosed type, with hollow cast iron frames that connect cylinders and bases. Such an engine is necessarily heavy per unit of capacity. Other engines have a cast iron frame between the cylinders and base at one side, and a solid steel rod or rods at the other side, but these engines must also be discarded as too heavy.

The nearest approach to a really suitable engine for ship dynamos that is found among present standard types is put out by several makers with four or more solid steel standards to connect the cylinders and the base. This last named type of engine is capable of production in very low weights, when parts other than the standards are made of the most suitable materials. Some engines on the market, however, in imitation of the steel rod construction between the cylinders and

base, have used standards of cast iron for the purpose. An engine with these cast iron standards is unnecessarily heavy, and is apt to be fatally weak in its frame. The most desirable construction for light weight in that part of the engine frame between cylinders and base consists of hollow steel standards.

Instead of cast iron, the bases of engines for ship dynamos should be of steel castings, because of the large reduction in weight for given strength and stiffness effected by the use of this metal. About the only parts of engines for electric plants on board ship that may rationally be of cast iron are the piston rings and perhaps linings for the cylinders. By suitable designs with wrought steel and steel castings in engines and wrought iron, steel, and steel castings in dynamos, the weights per unit of capacity may readily be reduced as much as fifty per cent for engines and twenty-five per cent for dynamos, below those often found in ship electric plants.

A meeting of the Board of Life Saving Appliances was held at the Post Office building in Boston, June 6, 1900, at which were presented a number of appliances intended for use in the service. The most important matter was the application of power in life-boats—a question which has attracted much attention, especially in later years.

A 34 foot life-boat at Marquette has had a gasoline tank placed in the after air case under the direction of Lieut. McLellan, by the Lake Shore Iron Works of Marquette, Michigan, and the boat gives promise of great usefulness.

The board adopted resolutions recommending that a special commission be appointed by the Secretary of the Treasury to inquire into the question of the application of power to life-boats, and with authority to make tests on the boats before mentioned. Such a commission was appointed consisting of the following members: Prof. Cecil H. Peabody, President of the Board on Life Saving Appliances; Lieut. C. H. McLellan, R.C.S. Assist. Inspector L.S.S.; J. G. Kiah, Superintendent 11th L.S. District; H. M. Knowles, Superintendent 3rd L.S. District.

Two members of the commission, Prof. Peabody and Lieut. McLellan, have gone to Marquette to determine the nautical properties of the lifeboat at that station, such as the displacement, stability, center of gravity, and also the power and speed of the boat on a measured course. As a basis of comparison the properties of a similar boat without an engine will also be determined.

The advantage of power in a life-boat, so applied as not to interfere with the essential qualities, such as the ability to right and free herself from water if capsized are sufficiently evident at a glance, even if the power be considered as auxiliary, the boat still retaining sail and oars.

At Belmore, L. I., a novel craft in which the owner intends to cross the Atlantic is under construction. The boat is to be 58 ft. long and schooner rigged. She will have a high freeboard, and will draw only 2 ft. of water. Besides her sails she will carry a gasoline motor with good supply of fuel for use in calm or head winds.

TUG RICHARD CROKER, FOR DOCK DEPT., CITY OF NEW YORK.

A modern type of well equipped harbor tug is shown in the drawings of the *Richard Croker*, recently constructed for the Department of Docks and Ferries of New York city by the Gas Engine & Power Co., and Charles L. Seabury & Co. Consolidated, Morris Heights, N. Y. She is a steel vessel of the following dimensions: Length over all, 110 ft.; length between perpendiculars, 100 ft.; beam molded, 21 ft. 6 in.; depth molded, at mid length between perpendiculars, 12 ft. 0 1-2 in. Steel of a tensile strength of 55,000 lb. and an elongation in 8 in. of not less than 25 per cent. is the material used for the hull.

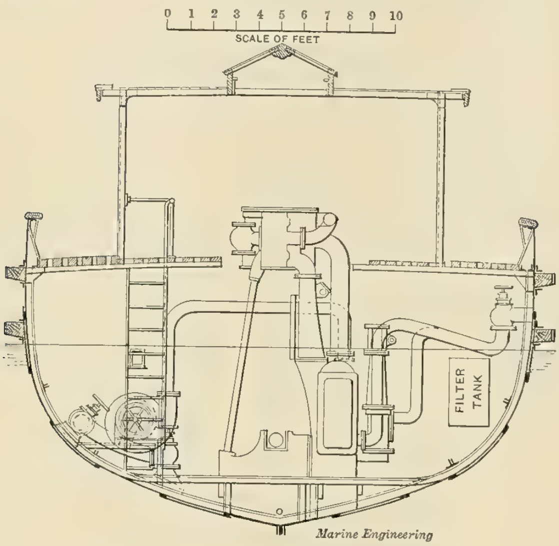
A solid iron bar keel 6 in. by 1 1-2 in. is fitted in lengths not less than 25 ft., with scarphs 18 in. long. The stem is also of iron, 6 1-2 in. by 1 1-2 in., rabbeted for the plating to about 3 ft. below the water line, and is scarphed to the keel. The stern frame and rudder post are forged in one piece of scrap iron, the main post being 5 1-2 in. by 2 in., counter connection, 5 1-2 in. by 3 1-2 in., rudder post 5 1-2 in. by 2 in., with the forward edge well rounded and with backing guards forged on. It is connected to the keel by a scarph 18 in. long. Frames are made of 2 1-2 in. by 2 1-2 in. by 5 lb. angles spaced 22 in. centers, and in one length from keel to top of frames. Scarph pieces of similar angles 3 ft. long are fitted across the line of the keel back of the floor plates, and are riveted back to back to every frame for one-half length of the vessel amidships. Frames at bulkheads are doubled. Reverse frames are 2 1-4 in. by 2 1-4 in. by 3.61 lb. angles. In the engines and boiler spaces these reverse frames are doubled to each floor plate and frame, one extending to the beams and the other to about 12 in. above the floor ends. Forward and aft of the machinery spaces there is one to each floor plate and frame, extending alternately to beams' end, about 12 in. above the ends of floor plates. Those extending to beam, butt at or near the middle line, and are connected by scarph pieces 20 in. long, and the others are in one piece.

Floor plates are in one length, on every frame, 28 in. deep in the engine space, 18 in. deep in the boiler compartment, and 12 in. deep forward and aft of these spaces. Under the engines they are 17.5 lb., under the boiler 15 lb., and forward and aft 12.5 lb. plates. The keelson is composed of two 3 in. by 3 in. by 7.4 lb. angles, riveted back to back. Main deck beams are of 3 in. by 3 in. by 7.25 lb. angles, worked with a crown of 3 in. in 21 1-2 ft. on every frame, and connected to frames by 10 lb. gusset plates, with 12 in. laps on frames and beams. The deck stringers are 3 ft. 10 in. wide and 10.5 lb. amidships, and reduced in width at the ends. The side stringers are two in number, of 3 in. by 2 1-2 in. by 6.53 lb. angles riveted back to back.

Transverse bulkheads are placed on frames 6, 18, 38, 48, and on frame 29 on the port side and 31 on the starboard side, forming the after ends to the coal bunkers. Longitudinal coal bunker bulkheads extend between the transverse bulkheads 18 to 29 on the port side, and 18 to 31 on the starboard side. All bulkhead plating is 7.5 lb. and is stiffened by 3 by 2 in. by 4 lb. angles. All bulkheads and doors are watertight.

For the outside plating, the garboard strake is 14

lb., the bilge strake 15 lb., and the shear strake 18 lb., the remaining strakes being 11 lb., except the bulwark strake, which is 10 lb. The plating is worked "in and out," single riveted, and at the butts double riveted. The tops of the sheer strakes are 5 1-2 in., and the bulwark strakes 22 in. above the tops of the beams at the sides. On each side there are three freeing ports 24 in. by 10 in. high, fitted with shutters. Gutters are formed by 2 1-4 in. by 2 1-2 in. by 5 lb. angles placed on top of the stringer plates, 8 in. inside of the plating.



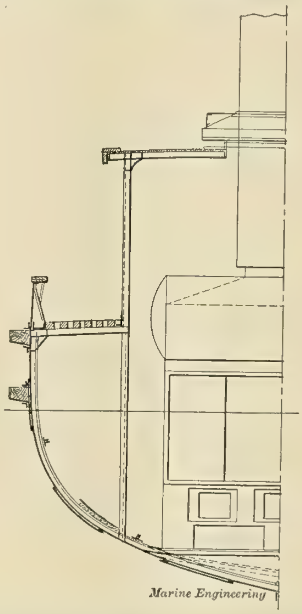
ENGINE ROOM OF TUG RICHARD CROKER.

White pine 3 in. square is laid on the main deck, and 2 in. square inside the house. The rail is of white oak 10 in. by 4 in., in lengths of about 20 ft., with 3 ft. scarphs fastened to the bulwark plating by 3 in. by 3 in. by 6 lb. angles. On top of the rail forward there are bow chocks of white oak 4 1-2 in. thick by 5 1-2 in. deep at the stern and reduced to 3 1-2 in. at the after ends. Aft the false rail is of the same dimensions. The upper fender is also of white oak 7 1-2 in. thick, and 8 in. deep, beveled to a 6 in. face, and running completely around the tug. The lower fenders on each side extend from the stem to about the after end of the house, and are of the same size as the upper, with a 5 1-2 in. face. Angles 3 1-2 by 2 1-2 by 6 lb., riveted to the plating by 3-4 in. rivets, extend along the tops and bottoms of the fenders, and the latter are bolted to the plating with 7-8 in. bolts. Both fenders are faced with iron straps 1-2 in. thick, secured by 6 in. countersunk spikes. On each side of the boat 10 swinging hickory fenders are hung, the main rail in the wake of the lanyards being protected by a covering of yellow metal 20 in. long and 15 in. wide.

Forward, the main bitts are 11 in. square white oak, with white oak cavil in two pieces 5 in. thick by 9 in. wide, securely bolted together, and they are stepped on top of the forward tank. Aft, the bitts are 14 in. square, and are stepped on top of the trimming tank. Rail bitts and nigger head forward are of cast iron, galvanized.

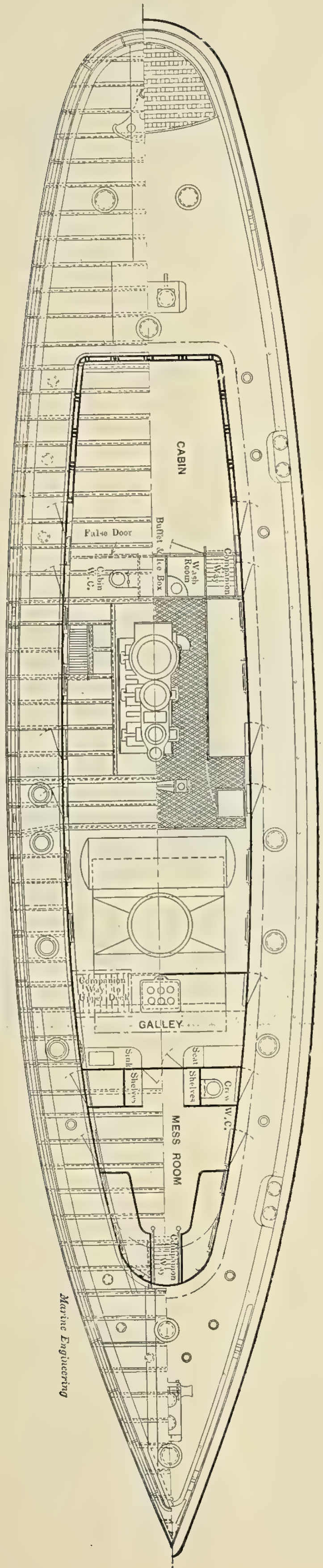
Steel is used for the deck house, which is about 66 ft. long and 13 ft. wide. The bottom coaming plates are 11 in. by 10 lb., connected to the deck plating and beams by 3 in. by 3 in. by 7.25 lb. angles. The top coaming plate is 8 in. by 10 lb., and the sides of the house are 8.5 lb. plate, stiffened by T-bars 2 in. by 4 in. by 5.5 lb. space 27 in. apart. Inside the house, at the forward end, a companionway leads to the sleeping quarters of the crew. The forward end of the house is occupied by the mess room, crew's water closet, and lockers. Aft of this is the galley, with regular range, sinks, etc., and from here a ladder leads up to the root of the pilot house. The machinery spaces occupy the greater part of the deck house, extending to the after compartment, which is furnished as the cabin, with buffet, officers' water closet and wash room. On the port side of the cabin, a companionway leads down to the officers' sleeping quarters.

The house is tastefully furnished and equipped. Composition is used for the air port frames, and these are 20 in. diameter. In the mess room, below the line of seats, there are transom windows admitting light and air to the forecastle. Over the engine room and cabin there is a skylight about 21 ft. 6 in. by 4 ft. 6 in., made of oak, with ribbed glass, protected by polished brass rods in ash frames. The hinges are also of heavy brass, and the same metal is used for the quadrants. at the top of the skylight. On top of the skylight, an 18 ft. metallic boat is carried in chocks, with davits which swing out, carrying the boat clear of the side. Polished cherry is used for the interior finish of the

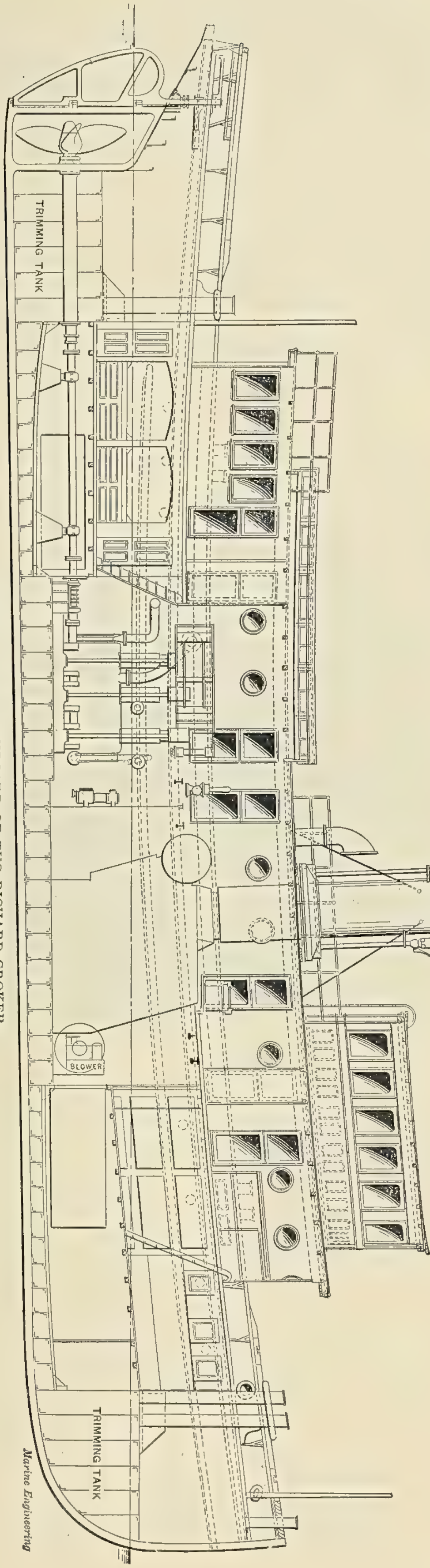


HALF SECTION THROUGH BOILER ROOM.

cabin, and the floor is laid with interlocking rubber tiling. Light and air in the cabin is provided by twelve drop windows 3 ft. high and 1 ft. 8 in. wide, four on each side and four in the end. In the lower after cabin there are four hardwood berths, with drawers underneath, and also clothes lockers and marble top washstand, with porcelain bowls and silver plated fittings. The decking on top of the house is white pine 1 1-8 in. by 3 in., tongued and grooved, and covered with No. 5 cotton canvas.



GENERAL ARRANGEMENT PLAN OF TUG RICHARD CROKER.



GENERAL PROFILE INBOARD OF TUG RICHARD CROKER.

On top of the deck house forward is the pilot house, 7 ft. high in the clear. It is built of pine, with cherry interior finish. There are windows all around, each 1 ft. 8 in. by 2 ft. 9 in., placed 3 ft. above the deck. It is fitted with steam steering wheel of polished brass, mahogany binnacle, eight-day clock, bell pulls, tell-tales and speaking tubes.

In the forecastle there is a combined steam and hand-steerer, the steering-rod passing down from the pilot-house through the mess room in a brass pipe. There are radiators in all the living quarters piped for steam heat. Other apparatus for the use of the deck department includes a galvanized gypsy windlass for 5-8 in. chain, secured abaft the forward bitts, with chain pipe leading to the locker in the forepeak, hose rack, hand force-pump, and 350 lb. folding galvanized anchor and 60 fathoms of 5-8 in. close linked chain, fog bell, 10 in. dia., 4 ft. foghorn, fire buckets and axes, and 60 regulation pattern life preservers and Lyle gun.

The propelling engine is of the triple expansion type. with cylinders 13 in., 21 in., and 32 1-4 in. dia., and 24 in. stroke, designed for about 800 I. H. P., at 180 revolutions. It has an open front, with turned steel columns, and the back columns, which carry the slipper guides, are cast iron, resting on the condenser. The H. P. valve is a piston valve, and the other two double-ported slide valves, all worked with the regular Stephenson link motion. Piston rods are forged steel 2 7-8 in. dia., with cast iron pistons fitted with cast iron rings. The connecting rods, of steel also, are 60 in. between centers, with forked upper ends and gib and cotter crank boxes. The built-up crank shaft has journals 7 in. dia. and 6 5-8 in. long, with cranks set at 120 deg., having pins 7 in. dia. and 6 1-8 in. long. Crank, thrust, and propeller shafts are mild open-hearth steel. The thrust-bearing is provided with five horseshoe collars, lined with white metal and mounted on 1 1-4 in. steel screwed rods, with composition distance nuts. For handling the engine, a steam reversing gear of the floating lever type is fitted.

All pumps are independent, and they include a vertical single steam cylinder air pump, centrifugal circulating pump, vertical duplex feed pump, auxiliary feed pump, fire pump, 8 in. and 5 in. by 12 in., arranged to draw from the tank, sea, or bilge, and discharge into the feed pipe, fire main, or overboard. There is also a bilge ejector. Under the forecastle there are two tanks, each of 1,200 gal. capacity, and under the lower after-cabin there are also two of 775 gal. each.

The boiler is of the builders' water-tube type, with 64.37 sq. ft. grate surface, and 2,975 sq. ft. heating surface. This is connected to a stack, the top of which is not over 25 ft. above the water line, so that the tug can readily pass under bridges in harbor work. The boiler is arranged to be worked with forced draught on the closed ash pit system, a blower being provided in the fire room for this purpose.

STEEL TUG, RICHARD CROKER.

Cast iron is the material used for the propeller, which is 8 ft. dia. and 12 ft. pitch, with a helicoidal area of 22.5 sq. ft.

The service performed by the vessel includes towing scows, pile drivers, derricks, rafts, etc., in the harbor and carrying the engineering staff on inspection trips. The maximum regular speed is 16 miles per hour, with 200 lb. boiler pressure and engines developing 750 I.H.P.

Designs for the *Richard Croker* were prepared under the supervision of Engineer-in-Chief J. A. Bensel, of the Department of Docks and Ferries of New York City. The contract price for the tug was $59,500.

BALANCING OF VERTICAL MARINE ENGINES DISCUSSED IN AN ELEMENTARY MANNER.*

BY J. MACFARLANE GRAY.

ELEMENTARY INTRODUCTION.

In the order of nature there is this necessary and unavoidable condition in every action, whether of a minute particle or of a large mass, that if its velocity in any one direction be changed there must be at the same instant, in connection with it, another mass or masses changing their rates of motion in the opposite direction at such a rate of change that, taking together their weights and their changes of velocity, the total change in one direction is equal and opposite to the total change in the other direction.

For example, if, in a steamship, a piston weighing 1 ton has changed its velocity downward from 50 ft. per minute to 400 ft. per minute, then in the identically simultaneous interval of time some other mass or masses in the ship must have changed their velocity upward by an amount equal to 1 ton and 350 ft. change of velocity, or 5 tons and 70 ft. change of velocity, or 70 tons and 5 ft. change of velocity; but, whatever the balancing masses may be, the sum of the products of their weights by their accelerations must be equal and opposite to 1 ton and 350 ft. downwards.

This balancing in nature is not a credit transaction. The acceleration of the piston and the balancing acceleration of the other mass or masses are identically simultaneous and co-existent. They accompany one another, and neither of them could exist for even the one-billionth part of a second separately.

If an engine is so designed that each moving part has continuously its image accelerities of other masses in the engine itself, with their centers of action in the same line, the engine is self-balanced, and it requires no compensatory variation of velocity in any other part of the hull to make up nature's balance, and the stress between engine seat and bed-plate is then that due to the resting weight of the engine only, and the holding-down bolts do no holding down, in regard to the effect of the working of the engine.

If the engine is not designed so as to balance in this way within itself, then must the hull move simultaneously oppositely to the otherwise unbalanced motion of the parts of the engine, with accelerity, which is in amount always the same fraction of the engine accelerity that the mass of the engine part is of the balancing part of the hull. In this way is the vibration of the hull constantly equated to the vibration of the engine.

I am here intentionally leaving out of consideration the part played by the water and the oscillations of the hull as a floating body, and as influenced by waves.

This necessary balancing of accelerations is another way of stating the fundamental principle, that action and re-action are continuously equal and opposite. Another way of stating the same principle is to say that the momentum of the universe is unchangeable.

Momentum of a body in any direction at any instant is the rate at which matter is, in that body, being transported in that direction at that instant. Momentum is, therefore, measured by the arithmetical product of the quantity of matter by the velocity. A heavy body at a low velocity may therefore represent the same momentum as a body of less weight at a higher velocity, the rate at which the transportation of matter in the given direction is going on being the same in the two bodies.

Moment, in science, has just the same meaning that it has in common language—namely, importance. The definition given in Thomson and Tait's *Natural Philosophy* is, "The moment of any physical agency is the numerical measure of its importance." The moment of a force about an axis is measured by the amount of work the force would do in moving through an arc of the same length as the radius or arm with which it acts. The arithmetical product of force by arm is the moment, but the idea in the measurement is force by arc of the same length as radius. When the balancing accelerities are not in the same lines the moments of their forces about any plane must be equal and opposite, if the engine is balanced in tilting action as well as in vertical force.

Change of velocity of matter is produced by force. The heaviness of a body is the force of gravitation, and its amount is measured by the accelerity it produces. "The measure of a force is the quantity of motion which it produces in unite of time." At Berwick the accelerity of gravitation is 32.2 ft. per second every second. This is the number which, slightly varying for different latitudes, is represented by the letter g for them all. The force of the same accelerity is the same, whether the change of velocity be the effect of gravitation or the result of mechanical action. Given the accelerity of any body in any direction, if we divide it by any g, the quotient will be the force per unit weight producing the accelerity, in units of the heaviness of unit weight at the place where that value of g holds good, no matter where the experiment has been carried out—on the earth, on the planet Jupiter, on the star Sirius, or on any cricket field in stellar space.

When the velocity of a body is increasing in a given direction, the force applied to the body in that direction exceeds the force applied by the body in that direction by an amount equal to the same fraction of the heaviness of the body that its accelerity is of g. I am here distinguishing between heaviness and weight. Heaviness is force; weight is quantity of matter.

When the steam piston is leaving its highest position, at the instant when its velocity is nil, the accelerity is greatest. The acceleration is then also nil. It is important here to apprehend the exact meaning of the terms employed. The word "instant" is literally, "not standing;" and this hint of its meaning, marked upon it, ought never to be lost sight of in making use of the word. "Instant" is not a portion of time. Instant is in time what "point" is in space—position without magnitude. We cannot, therefore, with strict accuracy say "in an instant" or "during an instant," but only "at" an instant. Motion has direction, velocity and accelerity, at any instant; no portion of time is included in the thought. Travel and acceleration are accomplished in time, measured between specified instants.

The popular meaning of acceleration is increase of velocity. I use the word in this sense only, and I employ the word accelerity to denote rate of acceleration.

*A paper read before the Institute of Marine Engineers, London, England.

The balancing of an engine is principally the balancing of the accelerity of the reciprocating parts of the engine—the piston, piston rod part of the connecting rod, etc. The rotating parts—the crank and the eccentric—are dealt with by themselves. The unbalanced vertical forces, in an upright engine, are the most important disturbers of balance. What is the amount of their accelerity at any position of the crank pin, taking at first a slot connecting rod? Generally this is said to be, regarding the connecting rod as of infinite length; but we cannot think "infinite length," and we can all think a slot connecting rod as in the old donkey engines. With this the vertical travel of the reciprocating parts is the same as the vertical travel of the crank pin.

Circular velocities are very conveniently expressed as being so many times the radius length every second. Do not be frightened if I ask you to allow me to represent this number of radius lengths by the Greek letter omega, . Any other unappropriated mark would serve the same purpose, but this is the symbol most generally used in books, and it is well to familiarize our minds with its meaning.

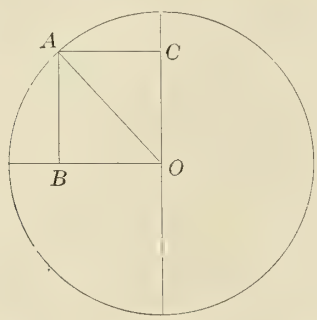


FIG. 1.

When a body rotates with velocity W, it is meant that every point in the body is describing a circle about the axis, or axle, of turning, with a velocity ω radius lengths per second, the radius length being the distance of that point from the axis. It also means something that is far more important. It means that every point in the body is describing circles about every other point in the turning body in the same transverse plane with it, also with the same velocity, ω radius lengths per second, the radius length being the distance between any two points, one regarded as the center and the other as going round it. No matter where in the transverse plane these points may be taken, the same ω, the same number of radius lengths, holds good.

If, then, OA Fig. 1 be the position of the crank, rotating with velocity ω from the vertical, and OC and OB the vertical and the horizontal center lines, the crank-pin A is moving with velocity ω times OA or ω OA in the circle. The velocity of A outwards is at the same instant ω AB, and the velocity of A downwards is $\omega \cdot$ AC. This is just what I have been telling you, that every point moves about every other point with velocity ω radius lengths per second, taking the radius length as the distance between the pair of points, which in this example is AB in one case and AC in the other.

Now, this is only velocity we have arrived at, and it is accelerity, not velocity, which operates in balancing. How can we get accelerity from these two velocities? How can we get the velocity ω. AC changed to accelerity, the rate at which $\omega \cdot$ AC, the downward velocity is changing at that instant? Evidently, if ω. AC be the downward velocity, then W times the rate at which AC is increasing will be the rate at which the downward velocity is increasing. The rate at which AC is increasing is the rate or velocity at which A is traveling outward, which we have seen to be $\omega \cdot$ AB; therefore $\omega \cdot \omega \cdot$ AB, or ω^2 AB, is the downward accelerity of A in this position. After A has passed the horizontal center line, AC will begin to decrease and the downward accelerity will then be negative, or $-\omega^2 \cdot$

In this problem we have an example of a kind of family of lines, BA, OA, CA; and just as in human relationships it is a great convenience to have one word—uncle, aunt, cousin, etc.—instead of telling the whole story of the intermarrying and propagation, so in geometry there are single words which express the relationship of BA and of CA to OA for any position of OA. When a line OA is drawn at an angle to another line OC, the direction of OA is partly sideways from OC, and, partly, the direction coincides with the direction of OC. The fraction that the sideways motion is of the line OA is called the sine of the angle AOC, and the fraction that the motion of A coincides with the direction of OC is called the cosine of the angle AOC. The fraction which CA or OB is of OA is therefore the sine of the angle AOC; it is the sideway travel. The fraction which BA or OC is of OA is the cosine of the angle AOC, for BA or OC coinicides in direction with the direction OC, from which the angle AOC is measured. I am associating the words "sideway" and "sine," and the words "coincide" and "cosine," merely to help the memory. When the line OA has turned so that A is below the horizontal center line the cosine is then negative. When A is on the opposite side of the line from which the angle is measured the sine is then negative.

Understanding the meaning of cosine and sine, and recognizing these terms when shortened to cos and sin, as they always are in trigonometry—the science of angle measuring—we can now change $\omega^2 \cdot$ AB into $\omega^2 \cdot$ OA cos AOC, or if R be written for OA, the length of the crank, we may write this as $\omega^2 \cdot$ R cos AOC, and if a be written for the angle AOC we can write

$$\omega^2 R \cos a = \text{accelerity} \ldots\ldots\ldots \ldots\ldots (1)$$

If OB and OC are "placed together," each in its own direction, a straight line from the beginning to the end will be OA. The word "component" means, literally, "placed together" or "put together," and OB and OC are therefore sometimes called the rectangular components of OA.

If any number of lines are drawn from O consecutively, that is, "following together," as A, B, C, D in Fig. 2, the ending point being P, then, as before, A, B, C, D are called the components of the line OP, not rectangular, because they are not at right angles. The dotted lines in the figure are the rectangular components of the several lines; they are the A cos a, A sin a, B sin a, B cos a, etc., and to show how the angles are measured from the vertical another figure is drawn with the respective arcs dotted, and you are requested to satisfy yourselves that the sum of A cos a + B cos b + C cos c + D cos d is the same as P cos p, and similarly that

$$\Sigma A \sin a = P \sin p \ldots\ldots\ldots\ldots\ldots(2)$$

Observe the meaning of the symbol Σ the Greek letter Sigma, or capital S. It is used to signify that the sum of all quantities similar to the one written after it is meant, and accordingly I might have written

$$\Sigma A \cos a = P \cos p \ldots\ldots\ldots\ldots\ldots(3)$$

In Fig. 4 I have put together the same components in

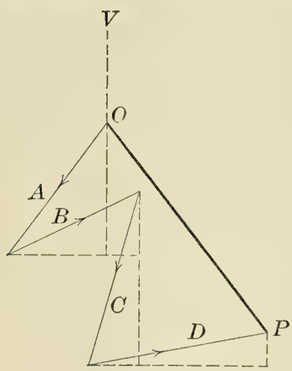


FIG. 2.

a different order to show that the order in which they follow each other is unimportant. The same resultant OP will be obtained. The directions and lengths of the lines alone are important. Observe that the same component is in all the figures parallel and drawn "towards the same parts," as Euclid would say, or "in the same sense," as our men of science now say, the "sense" being indicated by the arrow marks in the figures.

In Fig. 5 the components, A, B, C, D, are represented as crank weights on a shaft O, their resultant being the equivalent crank weight OP. The angles from the vertical are measured as shown, *a, b, c, d, p.*

If W be weight in pounds of the reciprocating parts moving along with crank R, then

$$\omega^2 \text{ W. R. } \cos a = \text{weight accelerity} \ldots\ldots(4)$$

at angle a from the vertical. Weight accelerity is what

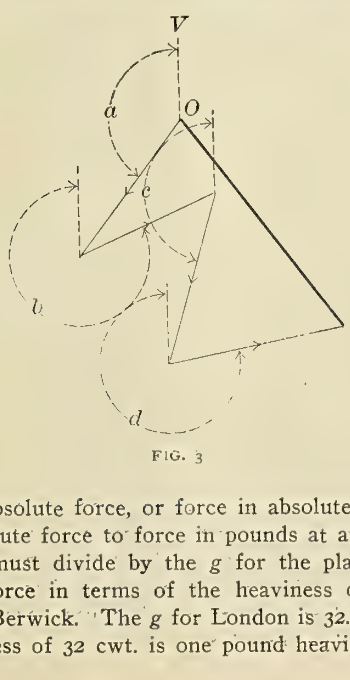


FIG. 3

is called absolute force, or force in absolute units. To bring absolute force to force in pounds at any specified place we must divide by the g for the place, say, by 32.2 for force in terms of the heaviness of a pound weight at Berwick. The g for London is 32.191, so that the heaviness of 32 cwt. is one pound heaviness less in London than in Berwick, although the weights are the same in the two places. Observe that R must be in feet if, as here, g is in feet.

It is more convenient for engineers to employ N = revolutions per minute, and in every case we may substitute

$$\frac{N^2}{91} = \omega^2 \text{ or } \frac{N^2}{2937} = \frac{\omega^2}{g} \text{ when } g = 32\cdot 2$$

$$\omega^2 \frac{W}{g} R \cos a = \text{force in pound heaviness} \ldots\ldots(5)$$

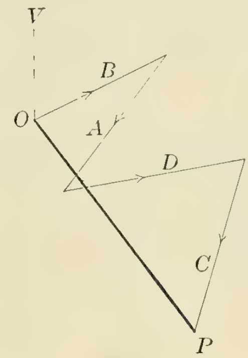


FIG. 4.

In the engine with the slot connecting rod this will be the difference between the steam pressure applied to the piston and the steam pressure transmitted to the crank pin and crank shaft and bedplate. At the same time the upward pressure of the steam, the same as acts downward upon the piston, is transmitted through the cylinder walls to the framing and the columns, and to the bedplate undiminished; and the difference is the lifting force acting on the bedplate and through the bolts, upon the engine seat and the hull in a steamship, relieving the hull to that extent of the weight of the engine. The action is reversed in the lower semicircle of the travel of the crank pin.

It is well to remember that the action is not reversed in the downstroke and in the upstroke, but in the lower semicircle and the upper semicircle.

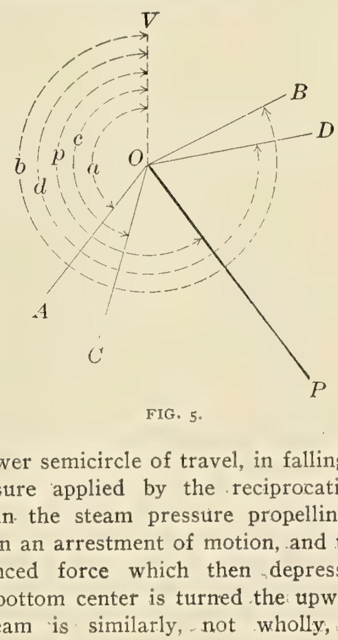


FIG. 5.

In the lower semicircle of travel, in falling, the downward pressure applied by the reciprocating parts is greater than the steam pressure propelling them, for there is then an arrestment of motion, and the excess is the unbalanced force which then depresses the hull. When the bottom center is turned the upward pressure of the steam is similarly, not wholly, transmitted

through the piston rod to the crank pin and the shaft, but the equal downward pressure of the steam is wholly transmitted downwards through the framing and bedplate to the hull, continuing the excess of downward force acting on the bedplate and engine seat and hull. In this way is nature ever watchful to prevent the universe from altering in any direction the motion of its center of mass.

Observe that the expression

$$\text{Weight accelerity} = \omega^2 \text{ WR} \cos a \ldots\ldots (6)$$

is merely an extension of the common formula for centrifugal force, which in absolute units is

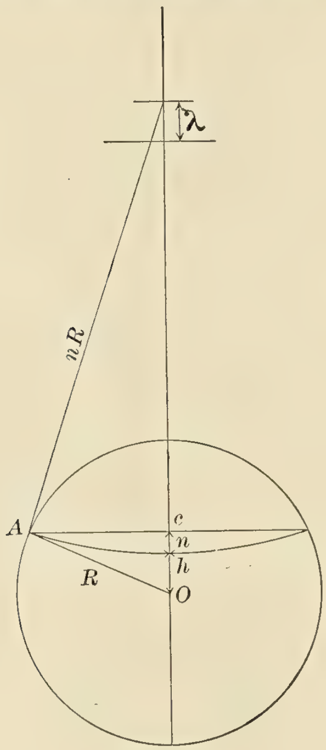


FIG. 6.

$$F = \frac{V^2}{R} W$$

when F = force in absolute units and V is velocity in feet per second. It must be observed that $V = \omega R$, therefore

$$\frac{V^2}{R} = \frac{\omega^2 R^2}{R} = \omega^2 R,$$

and $\quad F = \omega^2 WR \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$

and in (6) the only alteration is that R cos a is substituted for R, extending the centrifugal force formula to give the component forces in any direction for any position of the weight W in moving round a center O at distance R. The component forces are

ω^2WR cos AOC in the OC direction...... (9)

and ω^2WR sin AOC in the OB direction......(10)

We might have started from the rule of centrifugal force, and at once have resolved it into these components, but I have led you the longer way about to make the nature of the problem clearer.

When a swinging connecting rod is employed, the vertical movement of the crank pin is not the same as the movement of the crosshead and piston. Concentrating the whole of the reciprocating weight in a piston, the problem of the effect of the rod's obliquity may be represented diagrammatically as in Fig. 6, where h = the distance of the piston from the half stroke position, nR is the length of the connecting rod, and the half chord $Ac = R \sin a$, and x is the amount that the piston is in advance of the crank pin. I wish to take you all along with me in my reasoning, and I therefore recall to your minds some very elementary matters, which the majority of you know as well as myself, but one or two may not remember the reasons why. In a right angled triangle the square upon the side opposite the right angle is equal to the sum of the squares upon the

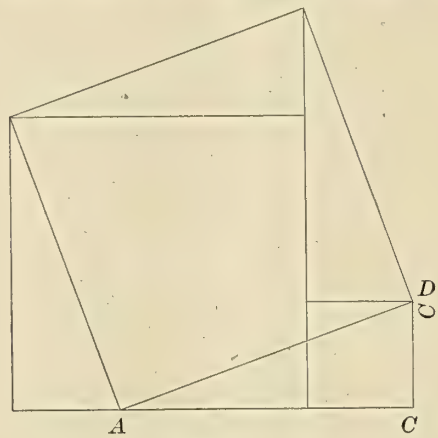


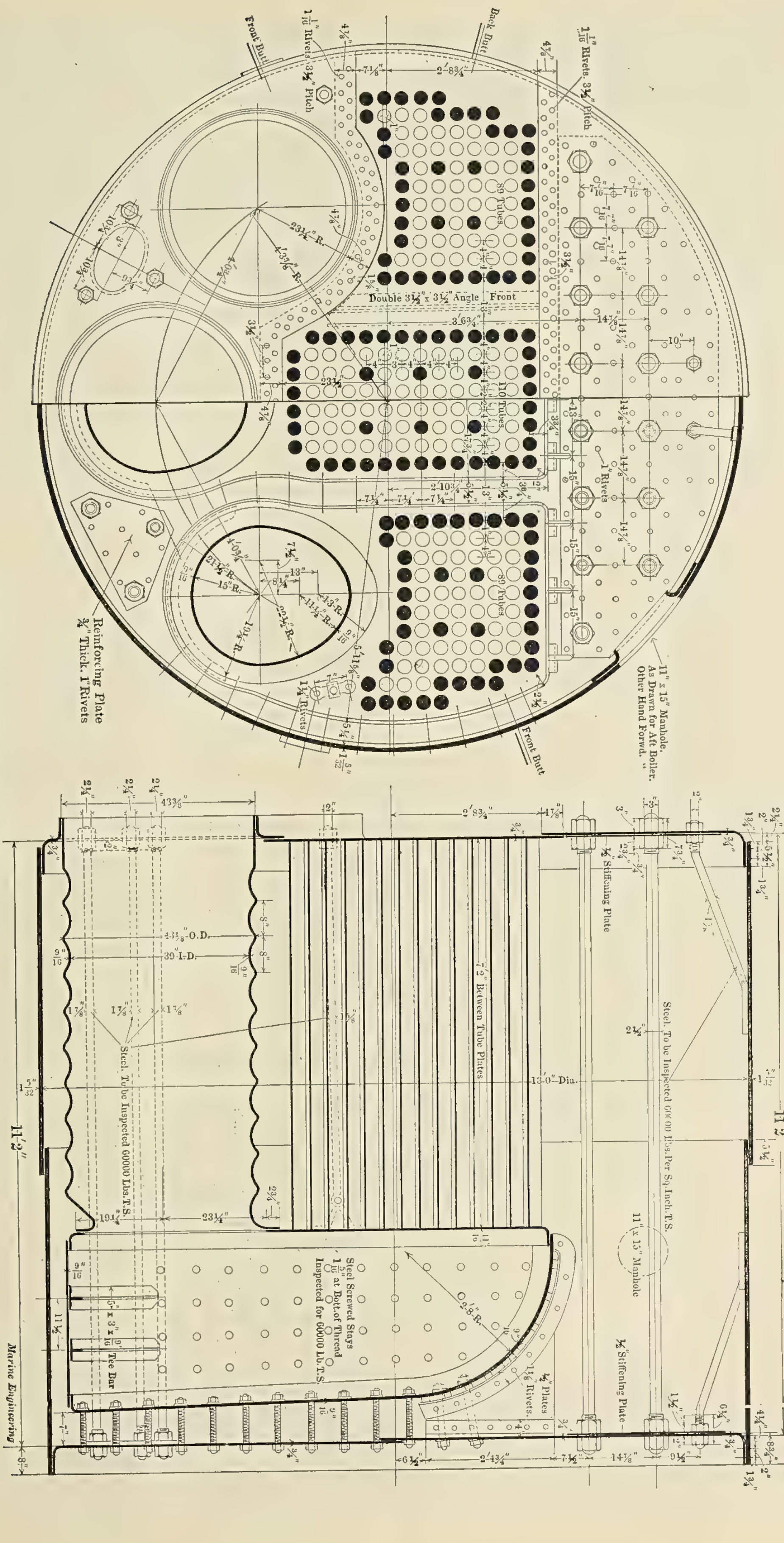
FIG. 7.

other two sides. That is to say, in Fig. 7 $AC^2 + DC^2 = AD^2$, which is obvious from the figure, but the demonstration is made still clearer when the diagram is formed in cardboard, and actually cut as the Chinese make it in ivory.

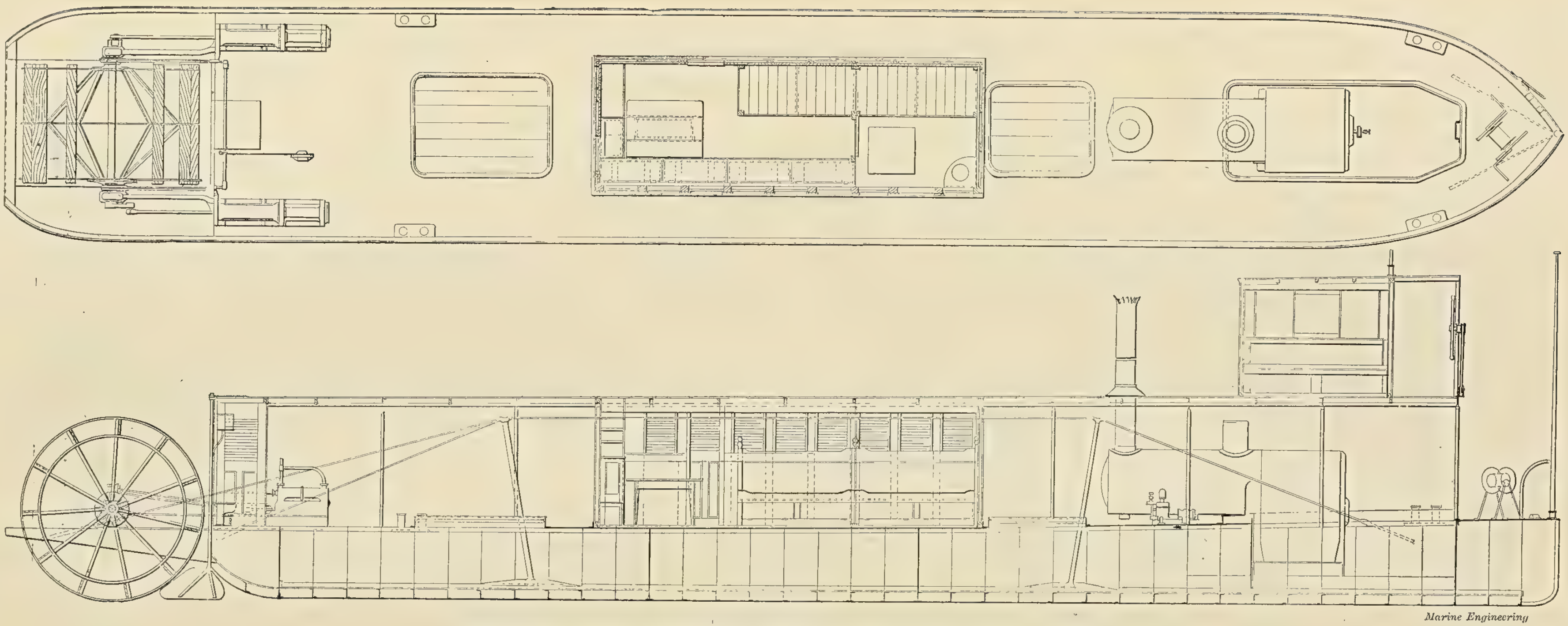
(To be Continued.)

High Pressure Scotch Boiler.

In the accompanying scale drawings are shown the construction of a Scotch boiler, which formed part of the machinery equipment of a moderate sized, sea-going, steam vessel, equipped with triple expansion engines. The boiler, as can be seen at a glance, is of the single ended, three furnace type, with separate combustion chambers, and is of these dimensions: Length, 11 ft. 2 in.; diameter, 13 ft. It is built of open hearth steel of a tensile strength of 60,000 lb. per sq. in. It was designed for construction in a plant fitted with heavy hydraulic tools, and it will be noticed that the back head is flanged outwardly for machine riveting. The tops of the combustion chambers are curved and stiffened with T bars, thus getting rid of one joint in each chamber, and the complication of crown bars and screw bolts and nuts. There are only two horizontal rows of main braces, the upper stays being diagonal with flanged inner ends riveted to the top of the shell. Morison furnaces with Gourly flanged ends are used, so that the furnaces can readily be withdrawn without, practically, dismembering the boiler. It was built to carry a working pressure of 175 lb. per sq. in. On the front elevation the stay tubes are indicated by solid ends. The boiler is well proportioned, a free steamer, and is a good example of modern American practice.



MODERN HIGH PRESSURE SCOTCH BOILER.



DECK PLAN AND INBOARD PROFILE OF MISSIONARY BOAT SAMUEL N. LAPSLEY.

Stern Wheel Missionary Steamer "Samuel N. Lapsley."

An interesting example of light draft special purpose boat is found in the stern wheel missionary steamer *Samuel N. Lapsley*, which was recently completed by the William R. Trigg Company of Richmond, Va., for use on the Congo River. Owing to the shallow water the boat will necessarily encounter, particular care had to be taken in its design to enable all requirements to be met. It was requisite that the boat have as light a draft as possible, yet a large cargo space was at the same time necessary. This was accomplished by giving a flat bottom and slightly rounded bilge, with a short, yet gracefully curved bow. The chief dimensions are as follows:

Length over all	70 ft.
Beam	12 ft.
Depth	3 ft. 6 in.
Draft	1 ft. 1 1-2 in.
Normal displacement	30 tons
Speed	8 3-4 knots

As the boat is intended to carry both cargo and missionaries to and from various points on the Congo, it is readily seen that comfort and space entered largely into the requirements.

The hull is built of steel throughout, with four transverse watertight bulkheads, and has ample space to store cargo. The forward compartment is occupied by the boiler and fuel space, while two large cargo hatches,—one forward and the other aft of the deck house,—give entrance to the remaining compartments.

The hull is trussed by means of tie rods, provided with turn buckles and supported by king posts. The deck plating consists of 5-lb. plates, with 7-lb. plate stringers connected to the sheer strake by 3-in. by 6-lb. gunwale angles. The keel, side, and bilge plating are of 8-lb. plates, while the bottom plating is made of 6-lb. plates. These have lapped seams with butts strapped and double riveted.

The deck house, which contains two rooms, is situated amidships and is built and framed of pine finished in white. The forward room has two bunks, lockers, wash basin, etc. The after room, besides the above, contains also a transom, pantry and folding table. Both rooms are well ventilated by numerous windows. The toilet room is situated aft immediately forward of the paddle wheel. On the upper deck, which runs the length of the boat, is the pilot house containing one bunk, and finished the same as the deck house.

LIGHT DRAFT MISSIONARY BOAT SAMUEL N. LAPSLEY

The boiler is of the locomotive type, with a grate surface of 350 square feet. The steam pressure is 150 pounds per square inch.

Placed aft are two horizontal, simple non-condensing engines with cylinders 9 inches diameter and 24 inches stroke. These are connected to the stern wheel which makes about 45 revolutions per minute at full speed. The engines develop 70 I.H.P.

An interesting feature of this boat is that it was taken completely to pieces, boxed up and sent to New York in freight cars, where it will be transferred and shipped to Africa.

The expense of the building of the boat was defrayed by various societies of the Southern Presbyterian Church. The christening took place in the yards of the William R. Trigg Company on June 23 before a large assembly, composed chiefly of members of the societies that have done so much to have their faith sent to the dark continent.

A PRACTICAL GEOMETRICAL METHOD OF LAYING OUT SHIP VENTILATOR COWLS.

BY C. M. JONES.

If two thin rings be secured together in any way and at any angle consistent with rolling, the trace due to rolling on a flat surface will be a pattern that cut from relatively thin sheet metal will form into a segment having bounding edges corresponding to the curvatures of the rings.

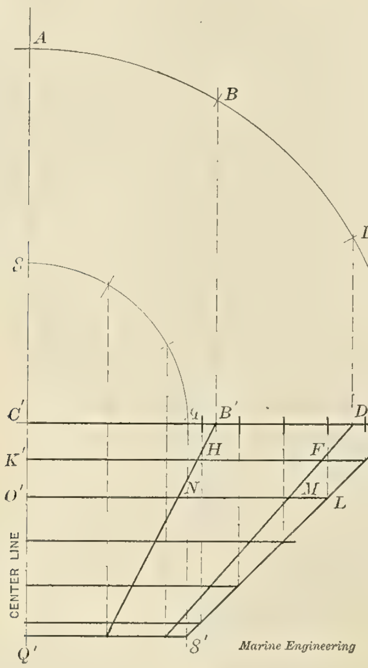


FIG. 3.

If points be marked off on either of the rings, and when in contact with the flat surface, the points of contact of the opposite ring be noted and marked, then straight lines drawn between such corresponding points on the pattern will remain straight when the segment is formed up.

The fact that such straight lines or elements of the surface can be found from the drawing of the segment enables the trace or pattern to be drawn without resource to actual rings, whether the segment be circular, elliptical, egg shaped, or of any other rational form of cross section.

Ventilation cowls aboard ship are generally of circular section, although sometimes made egg shaped at the mouth and gradually merged into a circle at the neck. Rarely they are made lop-sided, when fixed permanently in direction close alongside some obstruction.

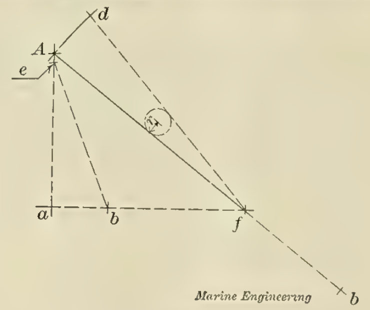


FIG. 4.

The method of development here given is for circular sections, but its general features are universally applicable and will enable all types to be laid out with the fewest possible lines and the greatest accuracy; the segments, when formed, simply "mopping" together if any sort of care has been used in the construction.

In Fig. 1 draw the profile *A, Z, I, 8, L* from the given sizes of neck and mouth, the throat radius being made as small as consistent with the necessary laps, and the "crown" curve being often struck, with a radius from some point on the horizontal through *8, Q*.

A circular crown curve, however, makes the inlet too flat at *E*, and the curve shown—which is between a circle and an ellipse—gives a better entrance for the air. The height, 8.0, is divided into eight equal parts, and the offsets—given as fractions of the total distance, *A, o*,—are set off and a smooth curve drawn through the points.

Divide the crown and throat into any desired number of equal parts—six are shown, but seven are usual—in order that the palm for the center pivot at *L*, on which the cowl turns, may be conveniently fitted, and drawn preliminary joints such as *EI. LO*, &c., and project the centers of such joints upon a center line, Fig. 2.

Set off the preliminary radii as *CA, KE, OL*, &c., from the center of Fig. 2, and through the points *C, K, O, Q* draw a curve as shown, and if it is not smooth and "fair" make it so and readjust the radii and crown curve to suit.

A thin flexible batten held to the points by means of weights or "dolphins" gives the best results for all such work.

Secure the batten "up and down" with the center line of Fig. 2 at the point *Q*, and then bend it to each of the other points. Place two dolphins at *Q*, one at and one *below* the point, and one at each of the other points. Hold *Q* and *C* and raise and then lower each dolphin *separately*, noting in which direction the batten tends to spring, if at all, when freed. A little manipulation of the points will secure radii on the curve of which the batten will lie neutral, and the crown curve must then be changed to suit, adjustment being continued until both curves are found "fair." The corrected crown

curve is then divided evenly and the true joints drawn in permanently.

In Fig. 3 describe quadrants[1] *ABDC,—8q.*, with radii of mouth and neck of ventilator, respectively, and divide each into, say, three equal parts. Draw *C,'C*, and *Q',8'*, equal to said radii and at such a distance apart that *c',8'*, the line joining them, will stand at about 45 degrees.

Project down the divisions of the quadrant, each upon its line, as shown, and draw straight lines *CL8'*, *D'FM*, *B'HN*, through the division points, and setting off the correct radii of the cowl joints and getting intersections on the slant line *C,8'*, such as *E,L*, &c., draw horizontals *EK'*, *LO'*, &c. The intersections of these horizontals, with the slant lines drawn between semicircle, *EfhKI*, the base circle, and project (square to *EI*) the points *F,H,K,R*, &c., to *f,h,k*, &c., or better, to avoid errors of projection, divide the base circle into the proper number of parts. Project *A C* and *Z* down upon the base line *I,E* (Produced to *a* and square of course to *EI*), thus getting the points *a,X,I*—the latter nearly. As *Xa* is very nearly equal (here) to *CA*, set off *Xc* equal to *CA*, and taking *Xa* as radius, sweep a semicircle through *c* from the point on *XC* shown a little to the right of *X*. This semicircle (properly a nearly circular semi-ellipse), is the plan curve of the ventilator mouth.

Project (square to *EI*) *B,D,C*, &c., the points of division of the face, upon this mouth curve, getting points *b,d,c*, &c., and pin such points with the corresponding

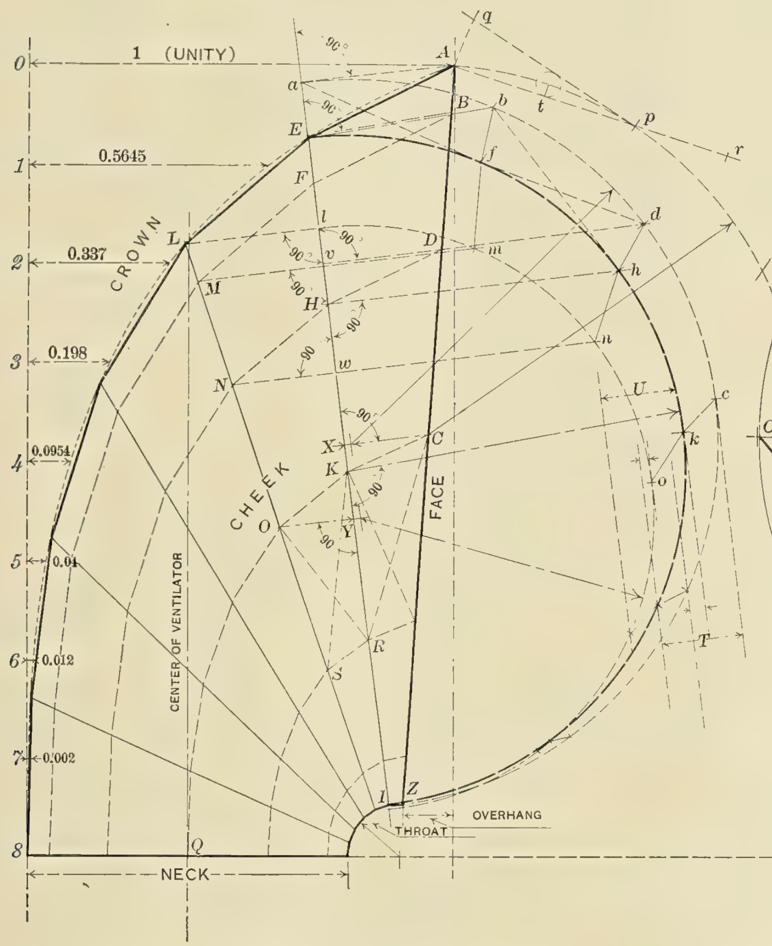


FIG. 1.

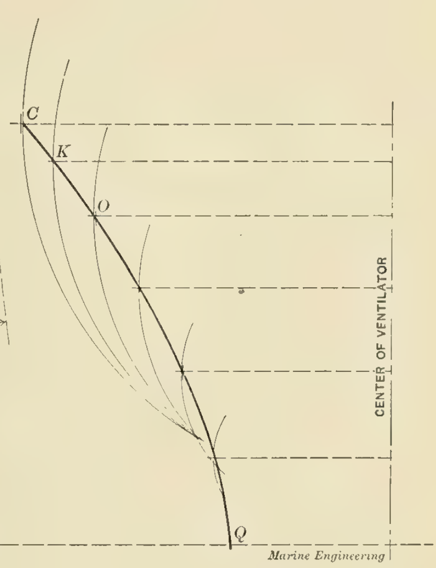


FIG. 2.

the division points, give division points for all the cowl joints. Setting off both sides from *C,K,O*, &c., (the centers of joints) of Fig. 1, the distances *C'B'*, *C D'*, *K'H*, *K' F*, &c., of Fig. 3, and drawing the straight lines shown, such latter lines are in profile the elements of the surfaces from which the developed segments are determined.

In Fig. 1 consider *E,I* the base joint for the segments right and left of it, and from the center *K* describe a points of division *f,h,k*, &c., of the base circle by means of straight lines, as per figure. These lines, *bf, dh, ck*, &c., are the surface "elements" in plan.

In Fig. 1 from *C* as center, strike an arc *Ap* (radius *CA*) and set off *AP* equal to *AB* of Fig. 3. This forms one division of mouth circle. Prolong the chord to *r*—making *pr* equal 1-2 *Ap*, and from *r* as center, strike an arc *Aq*. At *t*, the half chord, draw a circle with radius equal to the "round up" (or versed sine) of the arc as shown, and draw *pq* touching it. This last line will be tangent at *p*, and *pq* will be the true length of the arc,[2]

[1] This is for a circular cross section. For other shapes the points must be found by determining positions on the curves of tangents that are parallel in one plane.

[2] "Rankine's Rectification of Circular Arcs."

as closely as can be measured. This length is to be used in getting the distances *AB, BD, DC*, &c., shown in Fig. 5. *AE* in Fig. 5 being equal to *AE* in Fig. 1.

Find also the true length of the base circle arc *Ef*, this being used to set off *EF, FH, HK*, &c., of Fig. 5, as well as the upper division of the second section shown in same figure.

In Fig. 5 strike from *A* the true arc *pq* of Fig. 1, as above and also strike from *E* the true arc *Ef* of the base circle. In Fig. 1 take the diagonal chord *af*, and drawing a right triangle as in Fig. 4, set off said diagonal on the base as shown. From Fig. 1 take *Aa* in the dividers (the square distance that *A* is above the base

In Fig. 4 take *ab* equal to *fb* of Fig. 1, and also *ae* equal to *BE* of latter figure — *BE*, meaning here the distance from *B* square down to base line, *IE*, the perpendicular lying (by chance) close to crown point *E* — then *eb* Fig. 4 is the true length of the straight inclined element — *fb* of the plan Fig. 1, or profile *BF* (Fig. 1), and in Fig. 5, *FB* must equal this true length.

It will often occur that the first found points *B* and *F* of Fig. 5 require slight adjustment to conform to this latter standard check, as small errors are practically unavoidable, even when extreme care and good instruments are used. Ordinarily, however, correction can be made by the eye, and in any case dividing the joint curves

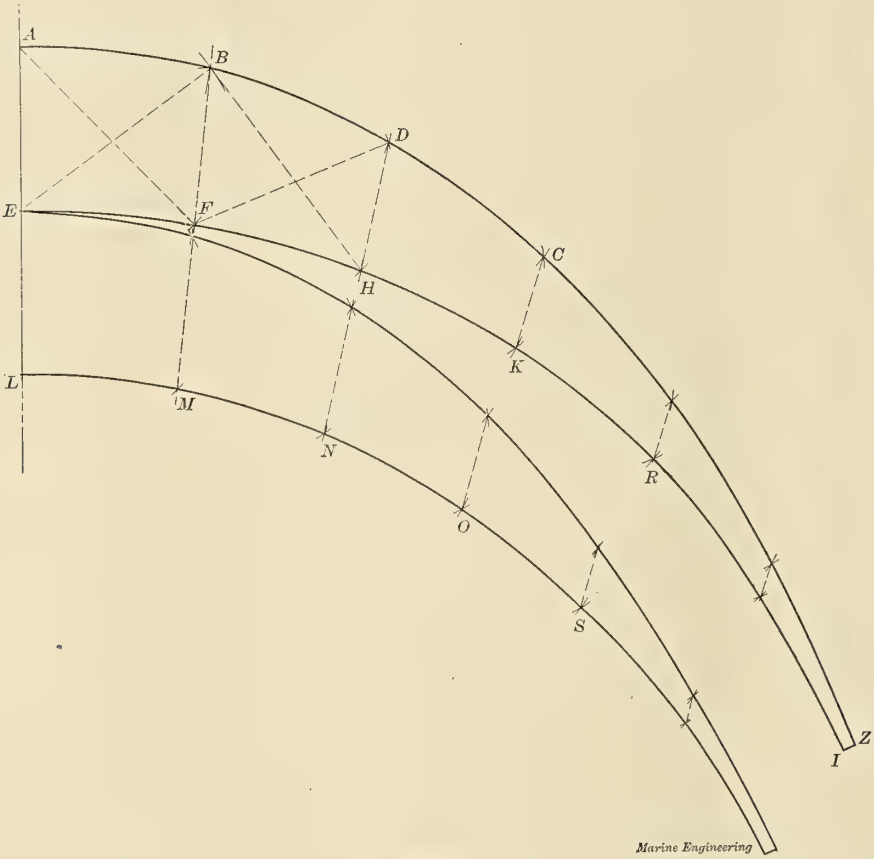


FIG. 5.

IE) and set it up as *aA* in Fig. 4. Draw *Af*, then this latter line is the true length of a straight chord (*af*) of Fig. 1.

Bisect this latter line and set up *r* — equal to the mean (half sum) of the round ups of the arcs, *Ap* and *Ef* of Fig. 1, and draw circle as shown, with *r* as radius. Draw *fd* touching this circle and prolong *Af* to *b* (*fb* = 1-2 *Af*). Strike from *B* on through *A*, cutting *fd* in *d*. Then *fd*, Fig. 4, will be very nearly equal to the true diagonal *AF* of Fig. 5, and from *A* (Fig. 5) as center and such diagonal as radius an arc struck through the already drawn joint arc at *F* gives *F* as point on the developed segment.

In the same way find the true lengths of diagonal *Eb* of Fig. 1, and with it as radius and with *E* as center find point *B* of Fig. 5, and draw straight line *BF* in the latter figure.

of Fig. 1 into smaller portions will show where the trouble lies.

Such subdivision should in most cases be carried out at the throat portions of the segments, as the intersecting arcs (Fig. 5) there make too acute angles to give satisfactory points of reference.

The points *BF*, Fig. 5, being determined, strike from them the joint arc lengths *BD* and *FH* and find their true lengths of curved diagonals — *bh* and *fd* of Fig. 1, being the plan lengths for one leg of the triangle and the heights *BE* and *Dv* being the other legs, from which to find the lenghts of *straight* diagonal chords and in this way continue until the whole half segment is laid out, the opposite half being its duplicate.

The second segment is found by projecting the center point, *O*, square to the base circle line *IE*, getting *Y* as projected center, and setting off the eccentricity as

shown at Y, describing the circle l, m, n, o, I (the distance oY, square to IE, being equal to OL, the true radius of joint $L\ O\ S$), and getting the surface elements, diagonals, arcs, as for the smooth curve.

The point below or at left of $L\ M\ N\ O\ S$ is to be used as base for the middle two segments, and there are, therefore, three distinct bases for the cowl shown.

The setting off of the eccentricity at X and Y instead of drawing the true elipses due to angularity of AZ and LS in relation to the base circle affects the result only to extent of actually making the segments form up into the curves drawn, instead of into perfect circles. Where eccentricity is great, due to rank angles at AEL, the true ellipses should be drawn if perfectly circular sections are desired.

A second method of getting the lengths of the straight diagonal chords (such as Af of Fig. 4) is as follows:

Let CR of Fig. 1 be required. Take CR as one leg of the triangle—previously explained—and through c on the mouth curve and the point corresponding to R (this latter is shown, but not *marked* on the base circle), draw parallel lines—parallel to the base line EI. The distance T between such parallels is the second leg of the triangle, and the diagonal thus found will be equal to that found by the first method given. but the legs of the triangles will usually differ.

These methods check each other and serve to point out errors of construction due to confusion of lines.

After the points of the developed segments are laid down as in Fig. 5, a flexible batten should be pinned to them and smooth curves drawn as shown. These lines are "construction lines," and the laps must then be set off and second lines drawn by which the segment is to be cut.

The joint laps are usually allowed on the convex side of the developed sections, or rather the lower segments have lap on their upper edges which enter the segments above them.

The mouth is finished by bending over a heavy wire or by a tube split and bent to form, the segment edge being brazed (or otherwise fastened) into the slit. In either case lap, or its equivalent, must be allowed.

The neck is usually riveted into a toothed ring that engages with a pinion to allow swinging the cowl from below decks to face the wind.

If the joint circles of a cowl be divided into parts such that the chords are near enough equal to the arcs, the refinement of allowing for round up can well be dispensed with.

Cowls of copper, such as fitted aboard naval vessels, are frequently formed of four pieces, crown, cheeks and neck, brazed together into rectangular cross-sections, and then beaten into smooth finished shape.

A very much less expensive method is to form them of three or more sections by the method here laid down and then, after brazing, bring them to finished size with the hammer, with a minimum of labor and the certainty of having practically uniform thickness of metal.

Twenty-eight vessels large and small are now under construction at the Crescent Shipyard, Elizabethport, New Jersey.

TORPEDO CRAFT—UNITED STATES AND FOREIGN-TYPES AND EMPLOYMENT,*—I.

BY LIEUT. R. H. JACKSON, U. S. N.

The navy list, on July 3, 1899, showed that we had, completed, 20 torpedo craft, and building, 33 more; in all, practically 50 of these vessels.

It is now time to ask ourselves what success we have attained with these vessels and what should be accepted as the standard type for performing the functions required for such vessels.

Three years ago, a paper on this subject, written by Lieutenant R. C. Smith, U. S. Navy, was published in the institute; he outlined the practices of the builders abroad at that time, and deduced from them, from the conditions to be fulfilled in our service, and finally from what experience had taught us with the two or three boats already built, that two types of boats were essential, advocating the building of only these standard types; he also pointed out some of the objections that would result from great variety in type and size.

Let us then examine our list of torpedo craft and see if they can be classified into two types. It will be seen at once that any attempt to arrange them according to length, displacement, speed, or armament, is practically impossible. It is only in the destroyer class, where a batch of sixteen were laid down at one time, that there seems to be anything like a standard. In this class we can say that there are sixteen boats with displacement of from 400-420 tons, with H. P. from 7,000-8,300, and a speed of 30 knots over a thirty-mile course. Having set this type to one side as a destroyer class, there remains on the list of torpedo boats from 46-175 tons, intermingled with destroyers from 146 tons to the standard destroyer of 420 tons; speed from 20-30 knots; and an armament of torpedoes and battery with but little more regard to law and order.

It is natural that these conditions have arisen, and far from regretting that such is the case, it may prove to have been of considerable benefit if properly considered.

Some of the reasons for our heterogeneous collection of torpedo boats may be found dependent upon the following conditions:

(*a*) It was the desire and policy of Congress to scatter the work throughout the country in order to foster the ship-building policy, and to develop the specialty of building small craft. This allowed many small firms that had but little experience in building vessels of this type to bid and submit plans, as it required but a small plant to turn out these vessels.

(*b*) Besides the variations resulting from the acceptance of plans of the different contractors, other variations constantly arose from practical difficulties met with by the contractors in carrying out the specifications. Some of these, no doubt, were due to lack of skill on the part of the contractors, and others to faults in the department's designs; others possibly to a desire on the part of the contractor to use a cheaper and possibly equally good design to replace the more costly one laid down by the department.

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

(*c*) Possibly a desire to build experimental types can account for some of the variations.

At any rate we have them; and having them, a close study of the performance of the different types, and their efficiency in the special rôle to which they should be assigned, ought to give us much valuable information, and lead to the selection of two, or at most three, types of boats that can then be standardized as far as possible.

In order to decide upon these types, information may be obtained from three sources.

First—The practice abroad of the leading powers. Until recently this has been almost the only source from which conclusions could be drawn; so, too, there ought to be a perfect familiarity with the results that are attained abroad with the different types in order to more closely judge the efficiency of our own types.

Secondly—The examination of the performance of our boats during the Spanish war, in which they performed almost every function except the one which properly belonged to them—that of attacking an enemy's fleet. Many important lessons in construction and engineering can be drawn from this source; but nothing tactical.

Thirdly—Consider the strategical points involved as a result of our isolated position, and the requirements for torpedo boats that are demanded thereby. From this, certain qualities will be found as absolutely essential for one class of boats, and certain others as the essential features of another. Knowing, then, what is to be required of the boat, an examination of the performance of our own boats and of those abroad should enable us to select the type of boat as a standard, possessing such qualities to the highest degree, and all boats should then be required to conform to this standard even to the most minute details.

The advantage of possessing uniform qualities is even greater in its application to a flotilla of torpedo boats than when applied to battleships. Equal speed, steaming radius, interchangeability of parts, all add materially to efficiency and economy of the boats.

Classification—Before entering into an examination of foreign practice, it would be well to fix our ideas by the selection of certain standards of comparison. The following classification is based on the displacement as giving the best indication of the sea-going qualities of the boat.

(*a*) Class O. Destroyers. Boats of high speed over 200 tons displacement; carrying guns and torpedoes.

(*b*) Class P. Sea-going torpedo boats (picked). All boats over 150 tons; they are capable of maintaining themselves at sea as long as there is a demand for their services; though on account of the relatively small number of officers and men, and the cramped quarters, they should be allowed to leave the squadron and return to port when opportunity offered.

(*c*) Class Q. Sea-going torpedo boats (questionable). All boats between 100 and 150 tons; these boats are sea-going, but not sea-keeping; two or three days continuously at sea being about all they can stand.

(*d*) Class R. Torpedo boats (stationary). All boats under 100 tons. They are properly not sea-going, as there is certain risk incurred in sending one to sea alone, especially for a sufficient distance to prevent her again reaching port before foul weather sets in.

The same letters are used in this classification by displacement, as are used in the English *Naval Pocket Manual* (where the classification is by length), by far the most complete and accurate list of torpedo craft now published.

The principal changes from the tables given in the manual are: (1) It reduces very much Class P (sea-going), also known as sea-going torpedo boats, throwing most of them into Class Q (questionable), also known as first-class boats; (2) it very much increases Class R (station boats). This class embraces all, or practically all, of the boats known as second-class, and some of the so-called first class boats.

The following table shows the classification more clearly:

CLASS.	DISPLACEMENT.	NAME.	LOOSE CLASSIFICATION.
O..	200 and over.	Destroyer.	Destroyer.
P..	150-200	Sea-going, picked.	Sea-going.
Q..	100-150	Sea-going, questionable.	1st class and sea-going.
R..	Under 100	Station.	2d class, station, vedette.

(*To be continued.*)

Ocean Lumber Rafts.

The announcement that an immense pile raft is now under construction on Puget Sound to be towed to Japan serves to call attention to one of the most interesting industries on the Pacific coast, and one in which the shipping interests are directly interested. The rafts constructed by Capt. H. R. Robertson on the Columbia river and Puget Sound during the past year or two are not only the largest of the kind ever built, but are in many respects of unique construction. Capt. Robertson some fifteen years ago commenced the building of these rafts on the Atlantic coast, but learning of the immense quantity of piles on the Pacific coast decided to transfer his operations, and has lately established a permanent raft building plant at West Seattle, Wash. It is anticipated that henceforth three or four rafts of the largest size will be turned out each year.

The average raft constructed by the Robertson Raft Co. is 625 feet in length, 55 feet beam, 38 feet depth and 24 feet draught of water. The hull and cargo of each comprises some 11,000 piles and upwards. These raft structures have all the appearance of a whaleback, being pointed at each end, with a hull outlined and built to buffet the heaviest seas with the safety of a sailing vessel. Indeed the builders claim that if fitted with rudder and canvas they could make very fair progress on their own account. The 11,000 piles which are worked into a raft of this kind average 60 feet each in length and the huge structure thus contains in the neighborhood of 660,000 lineal feet or about eleven times the pile cargo of a fair-sized sailing vessel.

The fact that one of these immense rafts may be taken to its destination with average safety and without the expense of employes beyond those on the towing steamer is an additional point in their favor from an economic standpoint. Indeed the only expense in building and marketing the raft is found in the first cost of the cradle; the services of about a dozen employes being required for three months, the

time ordinarily required for construction; and the outlay for some 5,000 feet of chain which is utilized to hold the piles together in their original form. The cost of the entire structure, including the cradle, does not exceed $5,000. The majority of the rafts which have heretofore been constructed by the Robertson Company have been towed to San Francisco and sold. The prices which they have brought would seem to insure an immense profit for the builders, but possibly the figures are not unduly high considering the risk involved.

CRADLE FOR LUMBER RAFT.

larged, and when completed contained fully 2,000 piles in excess of the original estimate.

Shipping interests on the Pacific have carried on some agitation against these immense rafts on the ground that the piles if broken up and scattered in a storm would prove a serious menace to navigation, but no active steps have been taken to restrict their construction. The raft builders, on the other hand, declare that they have taken precautions to reduce the danger to a minimum. The chains wrapping the hulk are two inches in diameter, and in addition to being placed only six feet apart from end to end are interwoven and bound in the staunchest possible manner, so that nothing but the severest storm could possibly disrupt the mass.

OCEAN LUMBER RAFT.

Probably the most remarkable feat in raft building which has ever been accomplished was performed recently at the West Seattle yard when a raft which was originally intended to consist of 12,000 piles was en-

U. S. Torpedo Boat Destroyer "Dale."

In MARINE ENGINEERING for August brief mention was made of the launch of the torpedo boat destroyer *Dale* on July 24 at the yards of the Wm. R. Trigg Co., Richmond, Va. The following particulars, together with the accompanying view of the launch, will be of further interest.

The *Dale* is the first of the sixteen destroyers now building for the Government to be launched. As it was a side launch, unusual interest was created and upwards of 5,000 people witnessed the scene.

Miss Mary H. Wilson, of Philadelphia, a descendant of Commodore Dale, after whom the boat is named, acted as sponsor and succeeded very well in breaking the bottle of "yellow label" over the bow of the destroyer as it took its initial plunge. The boat glided smoothly off the ways without a hitch of any kind and came to a standstill after having gone not more than 30 ft., resting gracefully on the water, with every line showing the fineness that will permit the high speed it is designed to make. The dimensions and particulars of the launching ways were as follows:

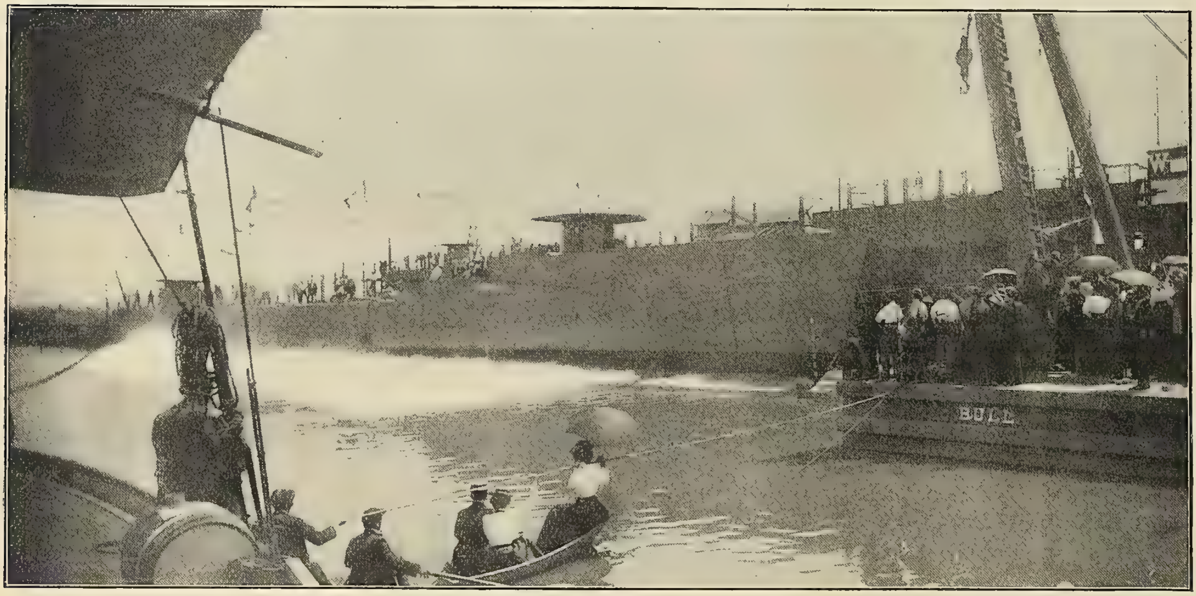
Groundways, 12 in. by 12 in., yellow pine.
Groundway shoes, 12 in. by 1 1-2 in., oak.
Slidingways, 5 1-2 in. by 12 in.
Length of slidingways, 23 ft.
Inclination of ways, 2 in. to 7 ft.
Number of ways, 10.
Bearing surface, 230 sq. ft.
Number of triggers, 5.
Launching weights, 193 tons.
Pressure per sq. ft., .839 ton.

A preparation of No. 1 Albany grease and beef tallow was applied about one-half in. thick on the ways and then covered with soft soap. Owing to the heat, considerable more tallow was used than is usually required.

The dimensions of the *Dale* are as follows:

Length over all	245 ft.
Beam	23 ft.
Depth	14 ft. 3 in.
Draft	6 ft. 6 in.
Normal displacement	420 tons
I. H. P.	8,000
Speed	28 knots
Thornycroft boilers, Daring type	4
Total grate surface	315 sq. ft.
Total heating surface	17,768 sq. ft.
Steam pressure, boiler	300 lbs. per sq. in.

Two four-cylinder triple-expansion engines. Diam. of cylinders, 20 1-2 in., 32 in., and two 38 in., each with a common stroke of 22 in.



LAUNCH OF THE U. S. TORPEDO BOAT DESTROYER DALE.

TORPEDO BOAT BARNEY.—At the yard of the Bath Iron Works, Bath, Me., on July 30, was launched the U. S. torpedo boat *Barney*. This boat is one of the number authorized by Congress in 1898. Her dimensions and chief particulars are as follows: Length, 157 ft.; beam, 17 ft.; depth amidships, 10 ft. 9 in.; mean draft, 4 ft. 8 in.; displacement, 160 tons; speed, 28 knots; cost, $170,000. The armament will consist of three pairs of r. f. guns and three tubes for short 18 in. Whitehead torpedoes.

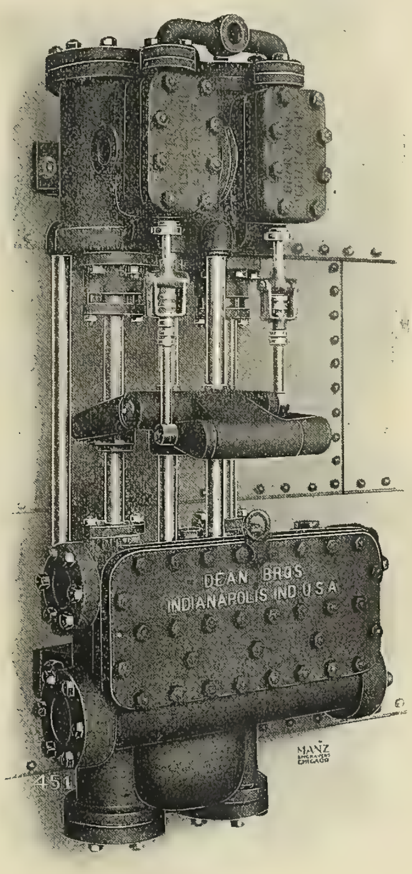
TUG FRED. E. RICHARDS.—At the yard of the Neafie & Levy Shipbuilding Co., Philadelphia, Pa., on July 24 was launched the steel tug *Fred. E. Richards*. The chief dimensions are as follows: Length, 135 ft.; beam, 26 ft. 6 in.; depth of hold, 15 ft. 6 in. The *Richards* is intended for the towing of steel barges of the Rockport Lime Co., of Maine, from Rockland to points of delivery, thus displacing the present use of sailing vessels.

SCHOONER PRETORIA.—At Davidson's yard, West Bay City, Mich., on July 26, was launched the *Pretoria*, said to be the largest wooden merchant ship ever built. She is 350 ft. long, 45 ft. 6 in. beam, 27 ft. deep, and is intended to carry 5,000 gross tons of ore, or 175,000 bushels of wheat.

IMPROVED APPARATUS.

Vertical Duplex Boiler Feeder.

The vertical duplex boiler feeder herein illustrated is sometimes known as the "Admiralty Style." All parts are made very heavy and the bolting is unusually strong to withstand the high steam pressure necessary for driving modern multiple expansion engines. The piston rods are of Tobin bronze and the cylinders are lined with the same metal.

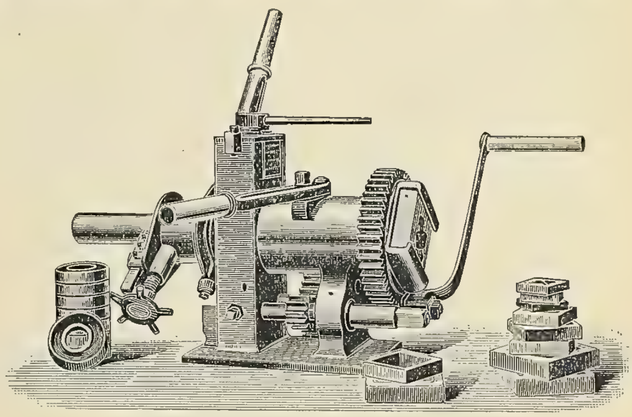


DUPLEX BOILER FEEDER.

The valve levers and rock shafts are of steel and no expense has been spared to make it a high quality pump. Pumps of this type are installed in places where floor space and head room are limited, where light weight is desired, and at the same time strength for working up to a pressure of 250 lb. per sq. in. The pump piston may be examined and repacked through the upper cylinders heads without disturbing permanent joints, piston rods or valve movement. This pump is manufactured by Dean Bros. Steam Pump Works, Indianapolis, Ind.

Pipe Cutting and Threading Machine.

The machine here illustrated and known as the Douglas patent pipe cutting and threading machine has been especially designed to meet rough and hard treatment at the hands of the unskilled labor usually employed for such operations. Ample strength and simplicity of construction are supplemented by compactness of design and a minimum of weight compatible with the strength required. Its weight complete with all its dies, guides, etc., is but 75 lb., and is therefore readily carried about and set up where most convenient to the work in hand. It is fitted with two



PIPE CUTTING AND THREADING MACHINE.

speeds of which the faster one can be used to "back off" after cutting a thread on a large pipe with the slow speed, thus effecting a saving of time. The machine will cut off and thread pipes from 1-4 in. to 2 in. inclusive, will cut long screws and close nipples, and is furnished with a complete set of solid dies and the necessary guides for that range of sizes. This machine is manufactured by P. Hollingsworth Morris, 1501 South Front St., Philadelphia. Pa.

The Crest Indestructible Sparking Plug.

It is well known that the sparking plug of gasoline motors is a delicate piece of mechanism often giving considerable trouble, and that the failure of motors can often be traced to the failure of this part of the apparatus. Although the jump spark method is the most largely used to-day on account of its simplicity, it would be universally used in preference to the contact and wide spark methods, if it was not for its liability to crack under the intense heat of the motors, short circuiting the secondary circuit.

THE CREST SPARKING PLUG.

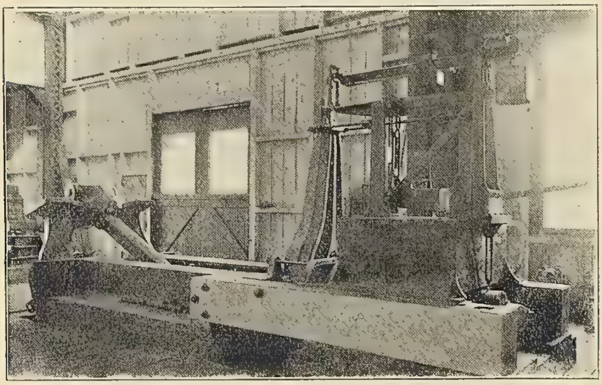
The Crest Manufacturing Company of Cambridgeport, Mass., manufacturers of Crest Motors for automobiles have recently put on the market a radically new design of sparking plug that is not affected by heat and expansion, and is consequently unbreakable. After considerable expense in experimenting with the best porcelain of foreign manufacture, they have, through the assistance of a well-known chemist, dis-

covered a new material that is unbreakable by heat or expansion. Sparking plugs made of this material have now been in use for a long time on their motors without reports of failure, and they have decided to introduce them to other manufacturers, and to the users of other makes of motors. The material used in this plug is a perfect electrical non-conductor and does not expand under intense heat. It is a soft tough material, not being brittle like porcelain. The sparking plug as shown in the cut consists of a shell of steel having a thread at one end to screw into the orifice in the motor chamber. The sparking plug proper consists of a small cone of this new material which is inserted in the steel plug. This cone fits tight in the shell, making a gas tight joint without packing, thus making the plug proof against carelessness in the hands of unskilled persons. Through this cone a wire with an enlarged head is passed, terminating at the bottom of the plug. A platinum wire is inserted in the body of the steel shell, the spark jumping across between the two points.

These plugs are sold singly or in lots of 25 to 100 to the trade.

Anchor Testing Machine.

About 100 years ago the anchor testing machine was first adopted by the British Admiralty, for the purpose of putting a pre-determined strain on a finished anchor to determine its soundness. The apparatus was crude in form, but served the purpose and the system of testing anchors has been kept up continuously ever since and has been officially approved by Lloyds Register. The anchor testing machine shown in the engraving has been constructed for the Baldt Anchor Co., of Chester, Pa. The anchors made by this company are of open hearth steel, and the castings are first annealed for seventy-two hours, after which the coupon is removed and tested. If this is satisfactory the anchor is suspended over an iron plate embedded in a concrete block and dropped a distance of 15 to 20

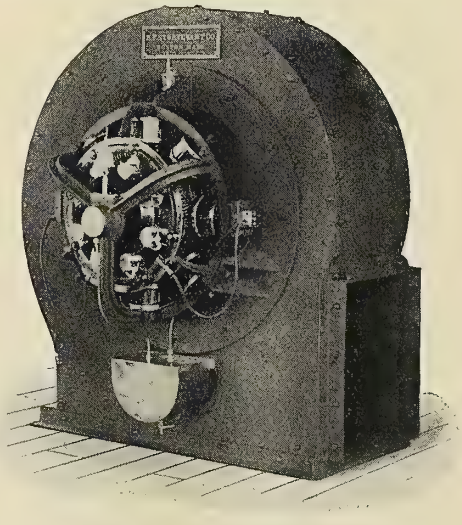


ANCHOR TESTING MACHINE.

ft., according to its weight and size. Having passed this test satisfactorily the anchor is then subjected to hammering as a further test of unsoundness. If all these tests are satisfactory to the inspector, the anchor is fitted up complete and subjected to test in the machine shown in the cut. The machine is capable of registering a pull of 350,000 lb., and by its means any desired stress may be put on the anchor in order to finally test it as a complete structure. A large stock of anchors thus tested is kept on hand by the Baldt Anchor Co., and they are thus in a position to supply at short notice anchors of any size and according to any test required.

Steel Plate Electric Fans.

The electric fan herewith illustrated has been designed with a special view to compactness. The shell is of steel plate, and upon its closed side is bolted a cast iron plate carrying three lugs, within which is centered and held the eight pole Sturtevant motor.



STEEL PLATE ELECTRIC FAN.

The field ring and cores of the latter are of wrought iron, the pole shoes being of cast iron, and of such shape and size as to render the machine capable of extreme variation of load without sparking at the brushes, and without necessity of adjustment.

The field coils are thoroughly insulated and machine wound, and are mounted on cores from which they may be readily removed. The open construction presents a great amount of radiating surface, thereby preventing the accumulation of heat. The armature has been carefully designed with special reference to low speed and high efficiency. Laminated slotted discs mounted on a cast iron spider form the core. These discs are solidly clamped between brass rings which support the edges of the core and protect the teeth from being damaged or misplaced, while presenting a smooth and well rounded corner for the support of the slot insulation.

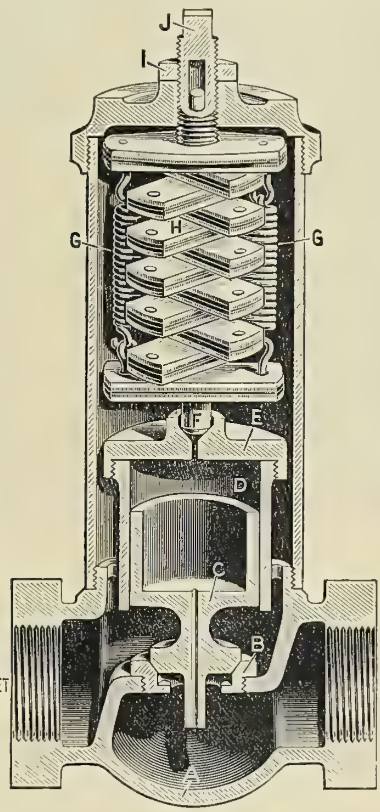
The construction of these cores and the manner of applying the coils is such that all parts are thoroughly ventilated, so that there is no danger of overheating, even when considerable overloads are carried.

The commutator is of large diameter, and consists of pure rolled or drop forged copper segments, supported in a cast iron shell of spider construction. Carbon brushes are used, and are supported upon a special rigging which is carried by brackets attached to the field ring.

A spider attached to each side of the field ring forms at its center a journal box which is provided with oil reservoir and ring oiler. The entire apparatus is designed and built by the B. F. Sturtevant Co., of Boston, Mass.

Thermostatic Steam Trap.

In this trap the adjustment is made according to the temperature at which it is desired the discharge shall take place. The condensation enters the body of the trap A, and passes through a small opening in the piston valve C into the cylinder D, thence through an opening in E into the thermostatic chamber, whence



THERMOSTATIC STEAM TRAP.

it drains back into the outlet side of the trap. If the opening in the piston valve is insufficient to carry off the condensation, the valve itself will rise and discharge to its full limit. Should steam or water at a higher temperature than that at which it is wished to discharge enter the thermostatic chamber, the bars H will become expanded and thereby cause the pilot valve F to close, thus shutting off escape from D, and forcing the piston and valve C to close down on the seat D, thus closing the trap against all discharge.

It is claimed for this trap that it will work equally well under high or low pressure, that it will discharge against any pressure less than the head pressure, and that it can be placed on a line of pipe like an ordinary valve, thus requiring no extra support. The seat is removable and the valves can be reground without removing the body of the trap from the pipe. The internal parts may also be removed without taking the body of the trap from the pipe and without the remaking of joints. It is also claimed that the thermostatic bars are sufficiently sensitive to insure prompt action both in discharge and closure, thus avoiding the unnecessary waste of steam.

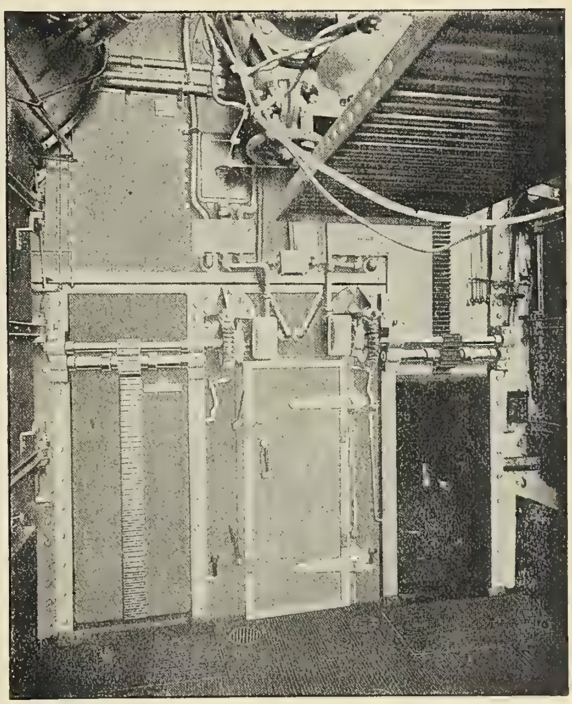
This appliance is known as the Bickel Steam Trap and is kept in stock in sizes from 1-2 in. to 2 in. inclusive by the General Sales Agent, Charles Bond, 520 Arch St., Philadelphia, Pa.

Safety Electric Water-Tight Doors.

No feature of a modern ship stands closer to the question of safety than water-tight sub-division, and the efficiency of the latter is almost entirely dependent on the prompt and reliable operation of the bulkhead water-tight doors which seem to be found a practical necessity in the actual operation of the ship, whether of the naval or mercantile marine. Three systems of power operation for such doors have been proposed, hydraulic, pneumatic and electric. The electric system herein illustrated is the result of the study given to this problem by Naval Constructor Francis T. Bowles, U. S. N., aided in the development of the electrical features and details by the Sprague Electric Co.

The following schedule of points are claimed for the system.

First. The door can be raised or lowered by power, or by hand, by one operator at the door on either side of the bulkhead.



U. S. S. ATLANTA, FITTED WITH ELECTRIC WATER-TIGHT DOORS.

Second. It will close either against the rush of water, or against a rush of mixed water and coal, or through coal on the door sill due to the first opening of a full bunker.

Third. It is possible to close by power from the bridge, or from one or more central or emergency stations, any desired group of doors, or all the doors simultaneously, or in any degree of succession.

Fourth. There is at each emergency station a positive and reliable indicator by which the closure of each door is made known.

Fifth. The operation of the emergency closing in no way interferes with the local operation by hand or power.

Sixth. The local control by power has precedence over the emergency closure, so that independent of such closure a door may be stopped or opened for egress. After the local switch is released the emergency again assumes control and closes the door.

Seventh. The leads which supply power, and which control the doors as well as the operating mechanism, are unaffected by any temperature conditions existing on board ship.

Eighth. The doors have no tendency to "creep," and will remain in any position without expenditure of power to hold them.

Ninth. The power is taken from the main generating plant of the ship, and requires no auxiliary central station or apparatus under continual and wasteful operation.

Tenth. There are no valves, springs or packing, subject to continual deterioration and requiring constant care.

The fulfillment of such a schedule would seem to indicate a successful solution of most of the problems connected with the power operation of water-tight doors. The system has been subjected to careful test at the Brooklyn Navy Yard, and has been installed on the U. S. S. *Atlanta*, S. S. *St. Paul* and other ships of the naval and mercantile marine. Further particulars may be obtained by application to the Sprague Electric Co., of New York.

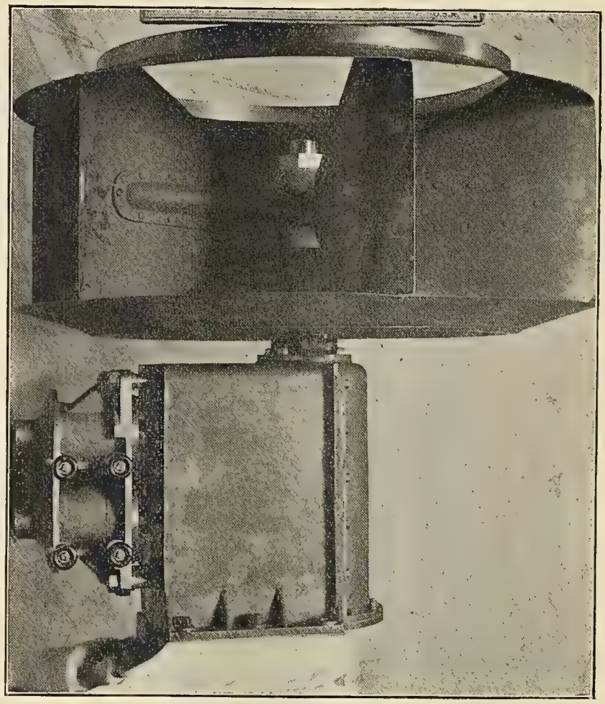
High Pressure Packing.

The continued demand for high grade packing for higher pressures, higher temperatures and higher speeds, to meet the requirements for all types of modern fast running engines, has caused the production of a packing which is designed to meet all these requirements. The packing shown in the illustration is known as No. 200. It is manufactured of selected fiber and metal in combination with the well known Garlock packing compound. No. 200 packing has been used on a large number of engines in the most extensive stationary plants in the country, and also on compound, triple expansion, and quadruple expansion, marine engines, in many instances with 200 lb. pressure, and invariably with satisfactory results. It is manufactured and sold by the Garlock Packing Co., Palmyra, N. Y.

HIGH PRESSURE PACKING.

High-Speed Ventilating Engine.

Careful examination into the causes of failure in engines only too often shows that it is due initially to the failure of some small relatively insignificant part of the machine. A 3-8 in. set screw shears or drops out, or some other like insignificant part is the starting point of the whole trouble. In fact it is fair to assert that in the majority of cases small details and not the main designs are responsible for the failure. Many steamship engineers assert that the main engines, developing enormous horse power, give comparatively little trouble as compared with the auxiliaries in the shape of blowers, pumps and circulating pump engines, etc., etc., which develop probably in comparison but a "few mouse" power. It is therefore a matter of great importance to have auxiliary engines which will run continuously for long periods of time, and without danger of heating, breaking down, etc. With this end in view the engine which is illustrated herewith was designed. It is either a horizontal engine set up on edge, or a vertical engine laid down on end, as one may choose to select. The shaft runs vertically and the cylinders two in number are at right angles to it. The oiling of the engine is accomplished by a small pump which forces the oil through the crank shaft to all the bearings including the guides and crosshead pins. This oiling system demands practically an enclosed engine which detracts somewhat from the appearance and adds somewhat to the weight of the engine and its first cost, but these features are so entirely offset by the certainty of lubrication that they are not to be considered as objections.



HIGH-SPEED VENTILATING ENGINE.

This engine is built by W. D. Forbes & Co., of Hoboken, N. J., and is one of a lot sent to the W. R. Trigg Co., Richmond, Va., for U. S. Navy torpedo boats.

The Taylor White Process for Treating Tool Steel.

One of the most notable features of modern industrial progress is found in the great reduction in the time required for productive and manufacturing operations. In all operations requiring the shaping of metals the problem resolves itself into two parts: (1) the production of the piece in the rough of such dimensions and form as to require the minimum amount of material removed for finishing, and (2) the removal of this material in the minimum of time. A most notable advance in the latter feature has recently been made possible by the "Taylor White" process for treating tool steels. This process is the result of a special investigation on the part of Messrs. F. W. Taylor and Maunsel White of the Bethlehem Steel Co. From a description of the process recently given to the public, the following points are abstracted:

A special lathe was set aside for the purpose of experimenting with tool steels of different makes with a view to the selection of a standard for use, and several picked men were set to work testing the relative merits not only of the different tool steels then in the shop, but of all brands of established reputation.

In the tests of these various makes of tool steels over 200 tons of steel forgings were cut up into turnings, and it is estimated that over $100,000 was expended in labor and material alone in developing this process. This large investment, however, was more than repaid in the first year by the saving in labor cost, and larger output in the shops. The increase in the cutting speed of the various machine tools throughout the shops has entirely reversed the inequality of balance formerly existing between the forge and machine shops, so that the capacity of the former has had to be largely increased in order to keep pace with the rapidly growing efficiency of the latter. The introduction of this process has made it possible to speed up the main line of shafting in the machine shop from 90 to 250 revolutions, and further changes in counter shafts have been made to give still greater speed to individual machines.

From a large amount of data the following results are reached: The average cutting speed has been increased from about 9 ft. per minute to 25 ft. per minute, or a gain of about 180 per cent. The average depth of cut has likewise been increased from .23 in. to .30 in. and the feed from .07 in. to .087, making an increase in the cross sectional area of the chips of about 60 per cent. This combined with the increase of cutting speed gives the relative weights of metal removed in the ratio of about 4.40 to 1, or an increase of about 340 per cent.

One of the especial features of this process is that it gives to the steel the very valuable and exceptional property of retaining a high degree of hardness when heated to a visible red heat. It is possible with one of these tools to cut steel at a speed so great as to heat up the point of the tool to redness and have it continue to cut for several minutes at this speed, leaving an unusually smooth finish on the work, as well as cutting accurately to size. The effect of the process which is applied after the tool has been dressed or machined to shape penetrates to the center of the steel, even in the largest tools treated, i. e., 4 in. square. All the standard brands of self hardening steel which have been experimented with are improved to a greater or less extent by the treatment. It is preferred, however, to us a steel of special composition in order to get the greatest uniformity and maximum results. This special steel forges so much more readily than the general run of self hardening steels that tools of different shapes may be easily made up. A simple and comparitively rapid method of annealing the special steel has also been discovered by which tools may be easily machined to shape, making it applicable to twist drills, chasers, inserted cutters, etc., tools which have heretofore not been made of self hardening steel.

A further important feature resulting from the use of this process is that the tools are extremely uniform in quality, so that work on which they are used can be readily performed at the maximum rate of speed.

LAUNCHES—HOME AND FOREIGN.

S. S. Sonoma.—The steamship *Sonoma*, built for the Oceanic Steamship Co., was launched at Cramps yards on Aug. 7. The *Sonoma* is intended for the trans-Pacific trade between San Francisco and Australia, and is of the following dimensions: Length, b. p., 400 ft.; beam, 50 ft.; load draft, 24 ft.; displacement, 9,700 tons. The designed I. H. P. is 7,500 and the contract speed is 17 knots. The ship is provided with accommodations for 400 passengers. The ship is one of three for the same line, the first, the *Sierra*, was launched in May, and the last, the *Ventura*, is nearly ready to leave the ways at the present time.

Schooner George W. Wells.—At Camden, Me., at the yard of H. M. Bean, the six masted schooner *George W. Wells* was recently launched. The dimensions of the *Wells* are as follows: Length on keel, 302 ft. 11 in.; length on top, 345 ft.; beam, 48 ft. 6 in.; depth, 23 ft. The net register tonnage is 2,750 tons, and the carrying capacity upwards of 5,000 tons. This schooner is the largest ever built for ocean traffic, and marks a further step in the development of the type as large freight carriers. She is fitted with a 30 H. P. steam windlass, and with pumps having a combined capacity of 1,200 gallons per minute. Her spread of sail is about 12,000 sq. yds.

S. S. Empress.—This steamer was launched on July 21 from the yard of A. D. Story, in Essex, Mass. She was built for the Beverly Transportation Co., and is intended for service between the mainland and Bakers Island. Her chief dimensions are: Length, 60 ft.; beam, 16 ft. 6 in.; depth, 5 ft. 6 in. She will have a gasoline motor for power and is intended to have a speed of about 8 knots. Her carrying capacity is 125 passengers.

Schooner Wm. C. Carnegie.—On Aug. 14 at the yard of Percy & Small, Bath, Me., was launched the five masted schooner *Wm. C. Carnegie*. The *Carnegie* has the following principal dimensions: Length 289.2 ft.; beam, 46.3 ft.; depth, 22.4 ft.; gross tonnage, 2,663.99; net tonnage, 2,380.93; carrying capacity, 4,500 tons. The vessel was launched, rigged and ready for sea. Her cost was about $115,000.

MARINE ENGINEERING

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AS we approach the last months of the century now drawing to a close, it is not unnatural to think of the future, and of what it may hold in store for those who go down to the sea in ships. The progress during the past century has been so absolutely revolutionary in character and far reaching in its results that it is perfectly safe to say that no human intelligence a hundred years ago could have foreseen the developments with which we are to-day familiar. It would doubtless be equally vain to attempt to forecast the developments of the century upon which we are about to enter. It may be, however, not without interest to take account of stock, so to speak, and to note at least for the engineering features of the problem the directions along which we may look for signs of future progress, leaving aside of course developments so revolutionary in character as to be entirely out of sight from our present standpoint.

In the first place there is nothing in sight which seems likely to displace some form of steam boiler and engine for the development of power.

If then the steam boiler is to be our reliance, at least for the immediate future, interest attaches to the question of type. Whether the boiler of the future will be shell or water tube, or whether both will persist as rivals, can now perhaps be only a matter of opinion. When we consider, however, the advances made by the water tube boiler in the last decade, especially in the Naval Marine, and remember its variability of form, its ready adaptability to high pressures, and saving of weight over its shell rival, it is not too much to say that in the minds of many the finger of progress points by way of this boiler, not necessarily or indeed probably by any of the types now existing, but more probably by some one or more types which shall result from the study now being expended on this problem.

As to the means by which the energy of the steam shall be transformed into mechanical work, we now see the field occupied by the common type of steam engine in which the reciprocating motion of the parts acted on by the steam is transformed into rotary motion of the shaft. A rival has, however, appeared in the steam turbine, a motor in which the parts acted on by the steam move in a rotary path at first hand, and hence simpler in many ways than the usual type of engine, and avoiding many of the difficulties due to the existence of reciprocating motions in its parts. The steam turbine, however, is far from being a perfected motor at the present time, and it is yet too early to say what shall be its share in the future development of marine propulsion. It seems not too much, however, to hazard the opinion that the role to be played by this form of motor is likely to be one of increasing importance. In no part of the field during the past one or two decades has the progress been more significant than in the reduction of weight of machinery per unit of power developed. A continuance of this reduction must depend on several factors: (1) The use of higher mean effective pressures. (2) The use of higher piston speeds. (3) The development of materials of greater strength for the same weight, and (4) The better use of such materials as we have, through greater care and improved design. In regard to higher steam pressures it is probable that boiler pressures will continue to increase up to a limit which can hardly be set at the present time. A corresponding increase in mean effective pressures is less likely, however, as this would tend to sacrifice the gain in efficiency due to higher boiler pressures. The piston speeds in use may be expected to gradually increase with improvements in materials and methods of construction, though it

would hardly seem justifiable to expect very rapid advance in this feature.

The outlook so far as new materials are concerned is not especially promising, and it seems likely that saving of weight must be attained chiefly by a better use of those already available. In this direction we may look with confidence for considerable advances.

Regarding the cost of power in terms of coal we may look for a slow and continuous decrease. Any such advance in this direction as has been attained during the past century is, however, entirely out of the question, except with some entirely new method of power development. As the steam engine now is, we are rapidly approaching the limit of the possible in regard to its efficiency, and naturally further progress will be at a slower and slower rate. The greater progress here will result from the studious effort to bring the average up to the present exceptional practice. In rare cases we have records of one I.H.P. per pound of coal per hour. This is already attainable therefore, and the problem immediately before us is to make such records the rule rather than the exception, and this without too serious a sacrifice of other desirable features of design.

For the actual instrument of propulsion there is certainly nothing in sight which seems likely to displace the screw propeller. We may go a step farther and say that in itself the screw propeller is susceptible of very little improvement. What is needed here, and what we may look for the future to supply, is a better understanding of the operation of the screw propeller and of its adaptation to special cases, so that we may be sure of always obtaining a propulsive efficiency not sensibly below the highest possible.

A FEW months since reference was made in these columns to the troubles which the British Admiralty were having in connection with the wholesale adoption of the Belleville boiler in warship design. Apparently a further stage has been reached and it is announced that the whole question is to be made the subject of inquiry on the part of a Board of Experts acting under Parliamentary authority. In the meantime the claims of the Scotch boiler are finding most doughty champions in Sir Fortescue Flannery and Mr. Allan, and Mr. Goschen will apparently need all the resources of his position to satisfactorily meet the criticisms which are made on the policy of the Admiralty in committing themselves so entirely to one type of boiler for the powering of large warships. Happily our own Engineer-in-Chief, Rear Admiral Melville, while coming out decidedly for the water tube boiler as a type for naval purposes, is far from pinning his faith to any one variety, and we may therefore with good reason hope that in the experience which may follow from this policy, results will be found which will go far toward showing what characteristics must be considered as necessary in the water tube boiler best suited to the needs of the Navy. The same experience should also aid in the consideration of the problem of the best boiler for the Mercantile Marine—whether here the Scotch or tank boiler is still preferable as of old, or whether the time has come when the water tube type may with advantage be adopted for certain Mercantile purposes. The experience with the larger American Naval vessels now being fitted with various types of water tube boilers will be watched with the keenest interest by all who are interested in the future of the Marine boiler.

WE give on another page a brief note relating to the financial report of the American Shipbuilding Co. for the past fiscal year. Earnings for what is practically the first year of its operation representing seven per cent on a capitalization of about $15,000,000 indicate a lively condition of lake shipbuilding, and excellent management on the part of the company's officials. How such gross earnings may compare with what might have been earned with the various yards under separate management, as before the consolidation, is, of course, wholly a matter of conjecture; but it is probably not too much to believe that future years, with a like prosperous condition of trade, will show results still more satisfactory to the stockholder than those for the first year's operation. In the meantime the various yards have a large number of vessels in hand and several more in prospect. A visit to the yards on the Atlantic coast and on the Delaware shows likewise a most astonishing amount of work in hand and in prospect. Whatever may be the conditions most favorable to the advance of our mercantile marine, business confidence in ships and shipping as an investment is certainly one of those most immediately essential, and, if the present condition of our yards may be taken as a proper index, it would appear that we are approaching a healthy condition of confidence on these points.

THE STEAM ENGINE.

AN ELEMENTARY DISCUSSION OF THE PRINCIPLES WHICH GOVERN THE ECONOMICAL USE OF STEAM FOR THE DEVELOPMENT OF POWER.—I.

BY DR. WILLIAM FREDERICK DURAND.

In the following discussion it will be assumed that the reader has a general knowledge of the chief properties of steam and of its relation to the heat which it contains. We will then take up in an elementary way a discussion of the principles governing its economical use in a steam engine.

At the very outset it must be clearly understood that we derive the work of the engine from the heat which the steam contains, and not from the steam in itself. The steam is simply a carrier for the heat and the operation of the engine is simply a means for transforming into useful work a fraction of the heat which comes into the engine, and then rejecting the remainder with the steam which is its carrier. The larger the fraction of the heat which can be transformed into useful work the better the efficiency of the engine, and the constant aim is therefore to turn into useful work the largest possible fraction of the heat which enters with the steam.

It may be asked, why not turn all the heat into work, and so realize a perfect efficiency? Unfortunately a series of natural laws and limitations seems to prevent all hope of realizing such an ideal, and actually we must be content with turning into useful work a comparatively small fraction of the total heat supplied. First and foremost among the causes of this reduction in efficiency is a principle or law sometimes known as the second law of thermodynamics. This law fixes a limit on the fraction of heat which can be transformed into useful work, such limit depending on the extreme temperatures between which the substance is worked in the engine. Thus if t_1 is the temperature of the steam at admission and t_2 that at exhaust, so that t_1 and t_2 are the two temperatures between which the steam is worked, and $(t_1 - t_2)$ is the range, then the law asserts that no engine, no matter how perfect, can transform into useful work a fraction of the entering heat greater than $(t_1 - t_2) \div (t_1 + 461)$. As another way of stating this relation, the temperature may be supposed to be measured from a point 461 or more accurately 460.7 degrees below the ordinary zero of the Fah, scale. This is called the *absolute zero*, and temperature measured from this zero is called *absolute temperature*. The difference of the temperatures would be the same no matter whether measured from the ordinary or absolute zero. The numerator of the above fraction is therefore the difference or range of temperature, while the denominator is the absolute temperature of the entering steam. The fraction of heat converted into useful work can therefore never exceed the *temperature range* divided by the *absolute temperature of the entering steam*. Thus to illustrate suppose that $t_1 = 370$ and $t_2 = 140$. Then the fraction becomes $(370 - 140) \div (370 + 461)$ or $230 \div 831 = .277$ or slightly over one-quarter.

These figures represent the limits for steam of about 160 lbs. gauge pressure, and it therefore appears that for engines operating between these limits this law steps in, and at one stroke reduces the ideal efficiency from one to about one-quarter; or in other words we are forced, due to the operation of this law, to throw away about three-quarters of the total heat, and at the very best with the most ideally perfect engine could only transform into useful work the remaining one-quarter.

Such then is the very best that could be done by a so-called *ideal* engine. The working substance in the simplest form of such an engine must be carried through a series of changes or operations, four in number, and specified as follows:

(1) The first operation must consist of an expansion at constant temperature, and all heat received from the source of supply must be received during this operation.

(2) The second operation must consist of an expansion with decrease of temperature during which, however, no heat as such is allowed to either enter or leave the substance.

(3) The third operation must consist of a compression during which the temperature remains constant and all heat removed from the body must be removed during this operation.

(4) The fourth operation must consist of a compression with increase of temperature, during which, however, no heat as such is allowed to either enter or leave the substance, and at the end of which the substance must find itself in the same condition as at the beginning of number (1).

Work is done by the substance during operations (1) and (2) and work must be done on the substance during (3) and (4). The difference between the work done *by* and *on* the substance will be the net work obtained from the heat in the substance, and the ratio of this to the total heat supplied during number (1) or the efficiency of the engine will be exactly measured by the difference between the temperatures of operations (1) and (3) divided by the larger increased by 461; or in symbols:

$$\text{efficiency} = \frac{t_1 - t_2}{t_1 + 461}$$

This is then the cycle and the efficiency of an ideal engine in the simplest form. There may be certain related variations in operations (2) and (4) making a more complicated cycle, but with the same efficiency. This ideal marks, then, the highest possible limit of efficiency for any and all engines working between the given temperature limits t_1 and t_2.

In Table I are shown the values of this limiting efficiency for engines with gauge pressure as indicated, all condensing and supposed to have a back pressure of 2.8 lbs. absolute, or a lower temperature, t_2, of 140°.

An examination of this table shows that with the ideal conditions which correspond to the operation of this engine, the fraction of heat utilized with modern boiler pressures would range from 25 to 30 per cent. These conditions, however, are far from those which actually exist in practice. Every one of the conditions specified above is violated in greater or less degree, and the result is that with the operation of the engine under the best conditions obtainable in actual

practice, the fraction realized will be only some 60 to 80 per cent of the figures for the ideal case as given in the table below. These figures, 60 to 80 per cent in the best practice, really measure the efficiency of the engine so far as the engineer is responsible. That is, nothing which he can do will serve to avoid the loss which reduces the limiting efficiency down to

TABLE I.

Gauge Pressure at Engine.	Limiting Efficiency.
100	.248
110	.253
120	.259
130	.264
140	.269
150	.273
160	.278
170	.281
180	.285
190	.289
200	.292
210	.295
220	.299
230	.301
240	.304
250	307

that for the ideal engine as given in the table above. His efforts are therefore limited to approaching as nearly as possible to the conditions of the ideal engine, and the figures 60 to 80 per cent measure the degree of approach which modern engineering practice has made to this ideal. Thus for illustration if the ideal engine could transform 25 per cent of the heat into useful work, a good actual engine working between the same temperature limits will be able to transform from 15 to 20 per cent, and similarly for other conditions.

To put the matter a little differently, any and all engines fail to transform into work all of the heat supplied to them. In the ideal engine as specified above, the part not transformed but rejected as heat is the least possible for all engines working between the same limits of temperature t_1 and t_2. In any actual engine the amount not transformed into work but rejected as heat is greater than in the ideal case. Such *additional* amounts of heat rejected and not transformed into work are called *wastes* or *losses*. That is, all differences between the performances of the ideal and actual engines are considered to be due to these so-called *wastes* or *losses*.

These various wastes may be classified as follows:

(a) *Radiation and Conduction Waste.*

This consists of heat which is radiated away from the hot surfaces of the cylinder, or conducted away through the columns and bed plate. The heat thus escaping avoids transformation into work and is therefore counted as a heat waste, or as an expense from which no corresponding return is received.

(b) *Initial Condensation.*

At the instant the steam valve opens, the steam rushes into the cylinder to find itself in contact with surfaces which have but recently been exposed to the influence of the condenser or external air. They are, therefore, at a temperature much lower than the steam, and in consequence a part of the heat is absorbed and a corresponding part of the steam is condensed. The heat thus absorbed by the surface of the cylinder and piston will be given up later during the exhaust period of the revolution, and thus communicated to the condenser. It thus appears that a thin skin of metal on the inside of the cylinder and on the faces of the cylinder head and piston may be considered in a sense as a place of hiding into which a portion of the heat slips on the entrance of the steam, and from which it escapes to the condenser or air without having taken part in the cycle of the engine, and hence without having contributed its part to the useful work done. The heat so escaping appears thus as an expense, but without any corresponding return in work, and therefore constitutes a heat waste.

(c) *Irregularities of the Cycle.*

We have specified above the four fundamental operations of the ideal engine cycle in its simplest form. In the actual engine none of these is realized, and the variations are all such as to count against the efficiency. Into the details of these points we cannot here enter, and the broad statement must suffice that with but few exceptions, the variations from the routine specified above for the ideal engine will count against the efficiency and occasion a heat waste greater or smaller as the circumstances may determine.

The Improvement of the Steam Engine. From the preceding section it follows that there are two fundamental methods open for the improvement of the steam engine from the standpoint of economy.

(1) An increase in the temperature range and thus an increase in the ideal or limiting efficiency.

(2) The saving of some of the various wastes as noted above.

The first raises the ideal efficiency and hence with a given proportion of wastes will raise the actual efficiency as well. The second raises the actual efficiency by carrying it a little nearer to the ideal.

The temperature range may be increased in two ways,—the initial temperature can be raised, and the final temperature can be lowered.

The continually advancing pressures in modern practice means a constant rise in the upper temperature, a constant increase in the ideal efficiency, and with the same proportion of losses, a corresponding rise in the actual efficiency. This is then the real significance of high pressures in modern practice so far as they are related to the question of economy.

Again by decreasing the back pressure from say 18 lbs. for a non-condensing engine to say 3 lbs. for a condensing engine, a very considerable decrease in the final temperature is obtained, a corresponding increase in the temperature range, and a resultant increase in actual efficiency. This is likewise the real significance of the influence of the condenser on the economy of the engine.

In general then, the proportion of heat wastes being the same, the economy will be better as the initial pressure is higher, and the back pressure is lower; or in general, as the range of pressure and temperature worked through is the greater.

We may turn next to the problem of reducing the wastes of the actual engine, as specified under the three heads above.

The waste due to radiation and conduction cannot be wholly avoided, but the former, which is by far the larger of the two, may be much reduced by suitable lagging or non-conducting covering. With such provision the loss under this head is usually very small compared with the other losses mentioned.

The waste due to the so-called initial condensation is one which may be reduced, but not wholly avoided. Before discussing the means suitable to this end some further explanation of the nature of the loss will be required.

As already pointed out, the action of the metal walls in producing this loss depends on their capacity when at a lower temperature, for absorbing heat from the steam (as during admission) and for giving it up when at a higher temperature (as during exhaust). The action depends, then, on the range of temperature between admission and exhaust, and on the particular readiness with which the walls absorb and reject heat according as they are cooler or hotter than their surroundings. There are therefore two distinct features to be considered—the range of temperature, and the readiness with which the iron absorbs and rejects heat under the conditions mentioned.

Now it is found that if the expansion through the entire temperature range is split up into a series of steps, each carried out in a cylinder by itself, the loss under consideration is less than if the entire expansion should take place in one cylinder. Carrying out this principle we have, of course, the multiple expansion engine with its total range of operation divided among several cylinders in series.

This, then, is the real significance of the multiple expansion (compound, triple, quadruple, etc.) engine, so far as its relation to economy is concerned—the splitting of the total expansion or of the total temperature range into a series of steps is found to reduce considerably one of the wastes, and so raise the actual efficiency of the engine.

Next turning to the other controlling feature of this loss,—the readiness of absorption and emission—it seems to be the case that once the internal surfaces become wetted or covered with a film of moisture, the absorption and emission of heat into and from the metal proceed with much greater readiness than when they are dry. In other words the passage of heat between metal with a moistened surface and moist steam is much more rapid than between the same metal with a dry surface and dry or superheated steam.

In the ordinary steam engine we have, therefore, an action of the walls due to the range of temperature employed, and to the natural capacity for cast-iron or steel to absorb and emit heat from and to steam, greatly augmented by the presence of a more or less complete film or layer of water over the surface, arising from the condensation of the first entering saturated steam.

The use of superheaters, reheaters and jackets is found in a general way to decrease the readiness with which heat exchanges occur between the metal and the steam, and thus to decrease the amount of waste due to their actions. Thus in an engine using moderately superheated steam we should have the same general tendencies as noted above for the operation with saturated steam, but less augmented because of the smaller amount of moisture formed. In an engine using steam superheated to such an extent as to remain above the point of saturation during its entire passage through the cylinders, no moisture is formed and the action of the surfaces is limited to that which can take place between their dry surfaces and the dry superheated steam. The office of superheating is then simply to reduce the readiness with which the exchange of the heat between the metal surfaces and the steam is effected. The results show that in such case the reduction is real and productive of a considerable increase in economy.

Regarding the use of reheaters it seems likely that their beneficial action will be well marked in proportion as they are able to superheat the steam passing through them, and thus act as a superheater in stages, each for the cylinder next beyond.

The beneficial results gained by the use of steam jackets are in large measure due to action of the same character. The jacket containing steam at a temperature higher than that in the cylinder transfers heat into the inner surface of the cylinder walls and thus tends to keep it dry and to reduce the amount of heat exchange, and hence the corresponding waste. The steam jacket acts also to some extent to modify the character of the cycle as noted below, but most of its useful action may probably be put down to the hindering of heat exchanges between the walls and the steam in the cylinder.

It must not be forgotten, however, that whatever gain is thus effected within the cylinder is obtained at the expense of the heat drawn from the jacket, and the whole operation is therefore an attempt to reduce one loss by introducing another. If the latter is less than the saving in the cylinder, the net result will be a gain equal to their difference. If the latter is the greater of the two, the net result will be a loss, and if they are equal the net result will be no change in the economy of the engine. These relations account for the varying experience with jackets, but it now seems well assured that when properly fitted and operated, the result will show a gain of from 5 to 10 per cent over similar conditions unjacketed.

We come now to the last principal division of the wastes of the actual steam engine,—those due to irregularities in the cycle, or in other words to variations from the routine of operations which would give the efficiency of the ideal engine as discussed above. In this respect but little can be done to improve matters. The use of jackets and reheaters may possibly affect the routine in such a way as to bring it somewhat closer to the ideal conditions, but this is by no means certain, and the benefit due to these appliances comes mostly from the decrease in cylinder condensation as explained above.

There are methods, however, of modifying the cycle of the engine by the use of a series feed water heater, in such way as to bring it somewhat nearer to the ideal cycle. Such a feed heater for a quadruple expansion engine may consist of say three chambers or heaters through which the feed passes in series. In the first it is heated by steam drawn from the L.P. receiver. It then passes on to the second chamber, where it is heated by steam drawn from the second I.P. receiver, and then goes on to the third chamber, where it meets with steam drawn from the first I.P. receiver. As the feed water thus becomes hotter and hotter it meets with steam of higher and higher temperature drawn from the successive higher receivers in the engine, and it is thus brought nearly to the

temperature of the water in the boiler. The exhaust from pumps may also be turned into the first chamber, thus making it a means of taking heat from their exhaust and of returning it with the feed to the boiler. Various modifications may be worked out in the details of the operation of such feed heaters, but in all cases their significance lies in the fact that the cycle of operations as a whole may in this way be brought a step nearer to the ideal cycle than would otherwise be the case. All such changes, if made in accordance with the proper principles, may therefore result in a saving of heat and in a gain in the economy of the engine, and in this fact lies the chief significance of the feed-water heater as a feature of modern engineering practice.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XXIV.

BY WM. BAXTER, JR.

ELECTRIC LAMPS.

Several kinds of electric lamps have been devised, but of these the only ones in actual use are the incandescent and the "Arc" lamps. The former are used in all cases where it is desired to obtain a number of small lights, while the latter are employed in cases where a powerful illumination is required.

Incandescent lamps are so simple in construction and operation, that a brief description of them will be sufficient. The lamp consists of a thin strip of carbonized card board or some similar material, this being connected with metallic terminals through which connection with an electric circuit may be made. The passage of an electric current of sufficient strength through the carbon heats it up to the luminous point. The carbon filament is inclosed in a glass globe from which the air is exhausted as completely as possible, the object of this arrangement being to prevent the burning of the carbon. If the globe of an incandescent lamp springs a leak, the air entering through it immediately burns up the filament. Carbon is used for the incandescent filament, because its resistance is many thousand times as great as that of a metallic wire of the same size, and on that account the heat that is developed in it is correspondingly great. If the filament of an incandescent lamp were not of such high resistance, a sufficient amount of heat to raise the temperature to the luminous point could not be obtained without greatly increasing the strength of the current, and as the energy absorbed by a lamp is equal to the product of the current strength by the voltage, it follows that the latter would have to be lower than with a lamp taking a smaller current. Low voltage is not desirable because then the wires that carry the current to the lamps have to be made larger, hence, the effort constantly made by manufacturers is to increase the resistance of the lamps so as to be able to run with a higher voltage. A sixteen candle power incandescent lamp requires on an average about 55 watts of electrical energy to keep it burning up to the full rated power; the watts being the product of the volts by the amperes, it follows that a 50 volt lamp requires a current of about one ampere, and a 110 volt lamp a current of one-half of an ampere, while a 220 volt lamp would require only one quarter of an ampere. For marine purposes lamps are of either 110 volts or less.

Arc lamps are not so simple in construction nor in principle of operation as the incandescent. In this type of lamp the light is produced by the burning away of the ends of carbon rods, therefore, mechanism has to be provided that will feed the rods together as fast as they are consumed. The light developed by the lamp is proportional to the distance between the ends of the carbon rods, that is, when this distance does not exceed a certain limit. If the rods are close together the light will be dim, and if they are far apart it will be bright, so that to maintain it at a uniform brilliancy it is necessary that the feeding mechanism be controlled by the distance between the ends of the rods, or by the length of the arc, which is the name given to the space that intervenes between the ends of the carbons.

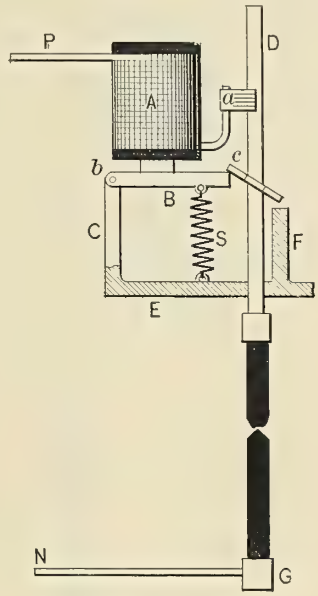


FIG. 157.

The simplest form of arc lamp is shown in Fig. 157. In this illustration, *P* is the wire through which the current enters the lamp, and *A* is a magnet that is arranged so as to lift the lever *B*. This lever is pulled down by the spring *S*. After the current passes through magnet *A* it reaches a sliding contact through which it passes to the rod *D*, which carries at its lower end one of the carbons. The action of the lamp is as follows: When the current is not passing through the lamp, the two carbon rods, the one attached to *D*, and the one held in *G*, are in actual contact, the top one resting upon the end of the lower one. If the wires *P* and *N* are connected with an electric circuit, a current will pass on account of the carbon rods being in contact. As soon as the current passes the magnet *A* becomes energized, and lifts the lever *B*. This lever raises the clutch ring *c* and thus lifts the rod *D*, causing the ends of the carbons to separate and form an arc. Although the carbon ends have been separated, the current continues to pass, but as the resistance of the space between the

carbons is very great, an amount of energy is required to force the current across the gap that is sufficient to raise the temperature to a very high point, in fact much higher than that of a blast furnace, or any other artificial heat. As the carbon rods burn away, the resistance of the arc increases, and as a consequence the strength of the current reduces. The reduction in the strength of the current results in a reduction

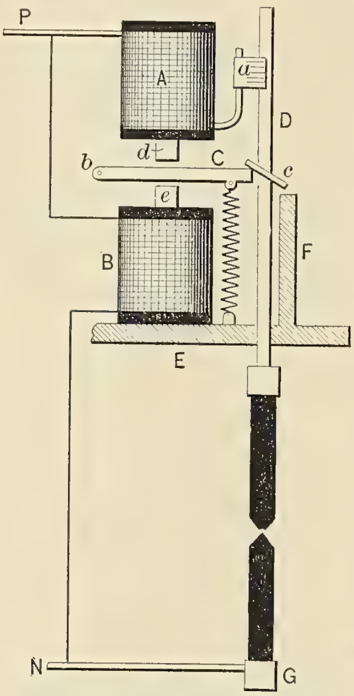


FIG. 158.

in the attractive force of the magnet *A*, hence, the pull of spring *S* is soon able to draw lever *B* downward. When *B* is drawn down a sufficient distance, the outer end of clutch *c* strikes the stop *F*, and the rod *D* is released, and slips through *c* until the carbon points come into contact. By this action the resistance of the arc is immediately reduced and the strength of the current is increased, so that once more the magnet *A* becomes strong enough to lift *B* against the pull of *S*.

The principle illustrated in this simple diagram is used in many designs of lamps actually manufactured, but the action is rendered more perfect by the addition of devices that prevent the rod *D* from moving too rapidly. It can be plainly seen that if the rod *D* can fall freely when it is released by the clutch *c*, its descent will not stop until the upper carbon comes into actual contact with the lower one; but if *D* can not fall freely, then it may not drop so far as to allow the carbons to come into contact, for as the rod descends the resistance of the arc decreases, and the current strength increases, and if *D* does not drop too fast, the current strength can increase sufficiently to enable magnet *A* to draw up lever *B* before the carbons come together.

Lamps constructed upon the principle of Fig. 157 cannot act if connected in series in the same circuit, because they depend for their operation upon the changing strength of the current. This type of lamp was used in the days when each light was operated by an independent machine, and it is also used at the present time for lamps that are operated from incandescent lighting circuits.

In order that a lamp may be able to operate in series with several other lamps it is necessary that the feeding of the carbon rods be controlled by the resistance of the arc, and not by the strength of the current, for with such an arrangement it is necessary that the current remain constant in strength. Fig. 158 illustrates the principle upon which lamps operate when constructed so as to work in series. In this diagram Fig. 157 is modified simply by the addition of a second magnet *B*. This magnet is traversed by a current that cuts around the arc; therefore, the coil is made of many thousand turns of very fine wire, so that the current that can pass through it is but a small fraction of that which passes through the arc. The operation of this type of lamp is as follows: When the light first starts up, the arc being short, its resistance is low, hence the current diverted through magnet *B* is so small that its pull upon lever *C* is much less than that of magnet *A*. As the carbons burn away, and the length of the arc increases, the resistance thereof increases, and the current through *B* is increased. In this way the pull of *B* gradually becomes stronger as the arc lengthens out, and finally the pull of *B* with the assistance of spring *S* becomes sufficient to overcome *A*, and lever *C* is drawn downward until clutch *c* strikes stop *F* and allows rod *D* to slip through. If the two magnets *A* and *B* are properly adjusted as to strength the spring *S* is not necessary, and in some of the lamps of this type it is not used.

The simple clutch ring *c* is not very desirable, as its sharp corners cut into the rod *D*, and in time roughen it up, nevertheless it was used for many years with

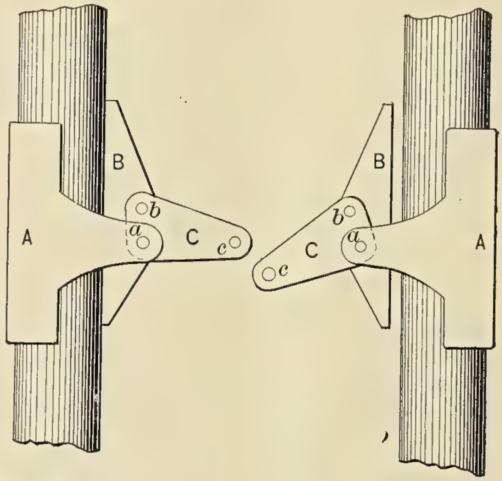


FIG. 159. FIG. 160.

the most successful of lamps. At the present time there are many modified forms of clutching devices, one of the simplest and most effective being shown in Figs. 159 and 160, the first showing the clamp when hugging the rod, and the second one when in the release position. As can be plainly seen, the shoe *B* is

forced up to the rod by lifting the outer end *c* of lever *C*, thus giving a powerful grip between *A* and *B*.

Arc lamps can be operated from incandescent light circuits, and in some cases they are arranged so that two are burned in series, while in others they are used singly Ordinary arc lamps require an E.M.F. of about 45 volts, so that if two lamps are connected in series in an incandescent circuit of 110 volts, each one will operate under an E. M. F. of 55 volts, unless a resistance is introduced to balance a part of the pressure. When a single lamp is connected across an incandescent light circuit, it is arranged to operate with an E.M.F. of between 80 and 90 volts, and a resistance is introduced to balance the remainder of the voltage. Lamps can operate upon incandescent light circuits whether made with one magnet, as in Fig. 157, or with two, as in Fig. 158. Fig. 161 illustrates diagrammatically the Brush lamp as used on incandescent light circuits. Its operation is as follows: When the light is turned off, the carbons do not touch, but are separated, as in the cut. When the current is turned on, it passes through magnet *A* and a resistance *R* and from here goes to a magnet *B* and thus to the opposite side of the line without passing through the carbons. This starting current is very weak, as it is held back by the high resistance of magnet *B*, which is wound with very fine wire. Magnet *A* is wound with large wire, therefore, the magnetism developed in it by the starting current is next to nothing, but magnet *B* becomes very strong on account of being wound with many thousand turns of fine wire. On this account *B* pulls up the armature *F* on the end of lever *C*, and as this lever is pivoted at *f*, the connecting rod *e* is drawn down and with it the clutch *c b*, which is of the type illustrated in Figs. 159 and 160. By the descent of the clutch the extension rod *h* is brought into contact with stop *i* and then the clutch opens and allows the rod *D* to slide through until the carbons come in contact. When this occurs, the current through magnet *A* at once becomes strong, for all the current that passes through the carbons passes first through magnet *A*, thence through resistance *R*, and then by way of contact *a* to rod *D*. As soon as *A* becomes strong, its pole *k* attracts armature *g* and thus the clutch *c b* is raised and with it the rod *D* and the upper carbon. The two magnets *A* and *B* are so adjusted in strength that springs are not required, there being simply a tug of war, so to speak, between the two. When the current becomes too strong, *A* predominates and lifts the clutch, and when the current becomes too weak *B* predominates and lowers the clutch. In order to prevent the movement of the lever *C* from being too violent, a dash pot is provided.

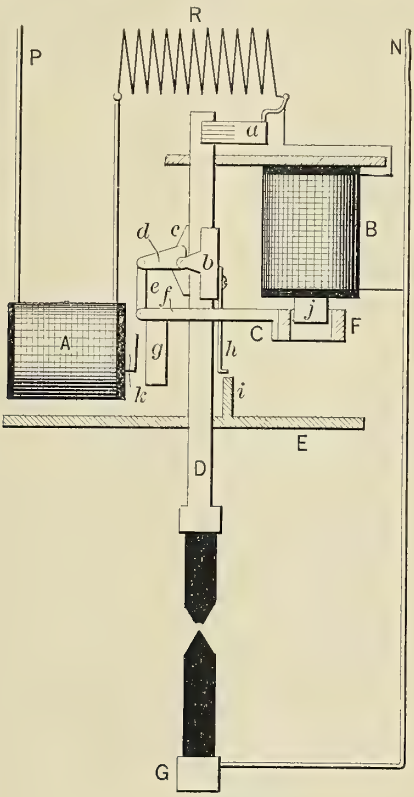


FIG. 161.

Nearly all the arc lamps used on incandescent light circuits are provided with a small globe that encloses the arc, and they are known on that account as enclosed arc lamps. The advantage of this type of lamp is that the carbons last from ten to fifteen times as long as in the open arc lamps, the greater length of life being due to the fact that the globe excludes the air and thus prevents the consumption of the carbon by actual combustion.

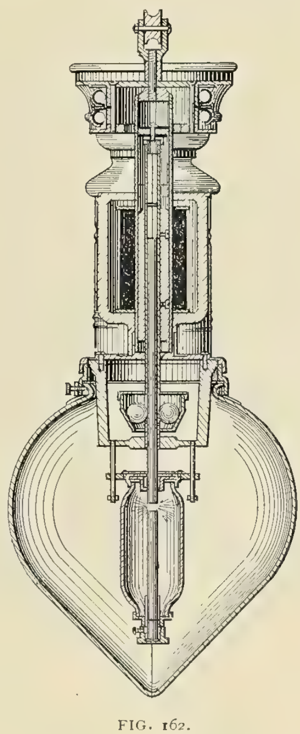


FIG. 162.

Some of the enclosed arc lamps have the mechanism so arranged that the rod *D* of Fig. 161 is not required, the clutch acting directly upon the upper carbon rod it-

self. By using this construction the length of the lamp is considerably reduced. Fig. 162 shows a lamp of this type. The clutch consists of a number of marbles, which are carried in a short conical tube. When this tube descends far enough, the marbles strike the upper end of a tube through which the carbon rod passes, and are thus drawn away from the latter, and allow it to slip through. The conical tube that carries the marbles is raised and lowered by the action of a magnet coil which is shown in section in the cylindrical portion of the lamp, just above the top of the outer globe. In the upper part of the lamp a resistance is located which is used to balance the excess of voltage.

RECENT LITERATURE.

OLD OCEAN'S FERRY. Compiled by John Colgate Hoyt, 1900. Published by Bonnell, Silver & Co., New York. Size 7 3-4 by 5 in. Pages 266. Cloth, 50 cents.

To quote from the subtitle, this book is "a collection of odd and useful information for nautical travel, and strange features of the sea for landsman and mariner." The average landsmanin making his first ocean voyage finds himself in a new world. The conditions of life are completely changed, everything is strange and new, and if of an observant nature he finds a thousand questions presenting themselves regarding his new environment. It is to furnish an answer to some of these questions that this little volume has apparently been written. It is, of course, a compilation with bits of information drawn here and there from the entire realm of the sea and nautical affairs. Only the index itself could serve to give a comprehensive idea of the ground covered. Some of the more important subdivisions, however, will give a general idea of the nature of the contents. Such are: Historical; Navigation for passengers; Ship and steamship records; Tables and information useful on shipboard; Commerce and shipping; Hydrographical; Sea life; Ancient and modern navies; Nautical notes; etc., etc.,

A few paragraph headings selected at random will serve to give a further idea of the range of topics treated. Such are: A brief nautical vocabulary; The latest theories and treatment for seasickness; Extracts from the U. S. customs laws and tariff schedules; Foreign mails; Cable rates to various parts of the world; Rules of the road at sea; Funnel marks, house flags, and night signals of the transatlantic lines; Signals at sea; Rules for hurricanes; Names of parts of a full-rigged ship; useful hints to passengers on ocean steamers; A collection of nautical conundrums, etc., etc.

The information given seems in general to have been chosen with good judgment, and to have been brought well down to date. The author can hardly have hoped to supply answers to all topics on which landsmen are liable to want information, but he has certainly made a long stride in that direction. There is also a large amount of information which will be found of great interest and value to those familiar with nautical affairs. As a whole this little book may properly claim to have been written in answer to a "long felt want," and it may be cordially recommended to all those about to take a sea voyage, or who may be interested in nautical matters.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Would you kindly decide on a disagreement of opinion regarding a fusible plug? A says a fusible plug will blow out of a boiler that has not been cleaned in three months. B says that it will not blow out only in case you lose track of the water. Have you ever heard of a case where a fusible plug blew out otherwise than by losing water?

A.—A fusible plug blows out because it melts; it melts because it becomes heated to its melting point; and it becomes thus heated because it receives more heat on one side than can escape on the other. The heat thus becomes banked up in the plug, so to speak, until the melting point is reached. Any condition, therefore, which will prevent the escape of heat from the water side of the plug while it is receiving heat on the fire side will result in the melting of the plug. Such a condition exists when the water falls below the level of the plug, leaving it in contact with steam only on one side and fire on the other. This is the usual cause of the melting of a plug, and is the condition which the melting is intended to indicate. There are other causes, however, which may prevent the escape of heat on the water side, and which may also lead to the melting of the plug. A sufficient layer of boiler scale might give rise to this condition, though such a result can hardly be expected from the usual type of plain scale. A layer of oil or grease, however, or of mixed scale and oil, is a very poor conductor of heat indeed, and experiments have shown that such a covering on the water side is quite sufficient to prevent the escape of heat and to lead to the melting of the plug, even though the level of the water is well above the plug itself.

NEW FREIGHT LINE ON LONG ISLAND SOUND.—The establishment of a new line of freight steamers between New Haven, Bridgeport, New York and Philadelphia is announced. The company which is back of the new system is the New York & Baltimore Transportation Co., of Baltimore, which is capitalized at a million dollars, and owns a fleet of many freight and passenger steamers.

The annual report of the American Shipbuilding Co. which controls practically all of the shipyards on the great lakes shows that it has turned out twenty-nine vessels during the past fiscal year with a carrying capacity of 17,000 net tons, and that sixteen vessels are now under construction. The net earnings of the company are also shown to be $1,100,665.85. After deducting $532,000 for a 7 per cent. dividend on the 7,600,000 of preferred stock, there remains $568,665.85, amounting to 7.48 per cent. on the $7,600,000 common stock. This is a most gratifying showing for the year, and is evidence both of the thriving condition of shipbuilding on the lakes, and of the excellent management of the affairs of the company for the year.

According to the returns from the Commissioner of Navigation one hundred and five vessels aggregating 35,944 gross tons were built in the United States, and officially numbered during the month of July.

MARINE ENGINEERING.

Vol. 5. NEW YORK, OCTOBER, 1900. No. 10.

SPEED TRIALS OF THE NEW BRITISH ROYAL YACHT VICTORIA AND ALBERT.

A series of trials of the sea going capabilities of the new British Royal yacht *Victoria and Albert* have recently been carried out by Admiralty officials. In the daily press a good deal of gush has been published as to the results of these trials, and this has been faintly echoed in some of the technical journals. According to the *London Times*, which on naval matters is usually authoritative, the "yacht has proved a capital seaboat, and has run in all her trials with admirable steadiness." We here present a reproduction of a photograph of the yacht as she was going out to sea on one of the trial trips. It will be observed that radical changes have been made in the appearance of the vessel as compared with the original construction. In place of the lofty heavy masts with which she was fitted before the "mishap" at Pembroke Dockyard, she now has short light sticks. The funnels have also been cut down, and for the original three, two only have been substituted. A great many structural changes have also been made with a view to get rid of topheaviness, and these are not apparent to the eye in the outside view.

BRITISH ROYAL YACHT VICTORIA AND ALBERT STEAMING OUT TO SEA FOR SPEED TRIAL.
Photograph Copyright 1900, by Symonds, Portsmouth.

The new yacht is of these dimensions: Length over all, 420 ft.; between perpendiculars, 380 ft.; beam, 50 ft.; displacement, 4,700 tons in 18 ft. draft. She is fitted with twin screws driven by four cylinder triple expansion engines of 11,000 designed horse power. She was intended to be capable of maintaining a sea speed of 17 knots and of reaching 20 knots when pushed. Belleville water tube boilers were fitted. The hull was built at the Royal Pembroke Dockyard and the machinery by Humphreys & Tennant.

The steaming trials were carried out in the English Channel. There were three preliminary trials at about half and three-quarters speed each of 48 hours' duration, and a final full power trial lasting eight hours. On the second trial the following were the mean results: Revolutions, starboard, 128.2, port, 129.7; I. H. P., starboard, 3,765, port 3,884, total 7,649; speed, 18.47 knots, coal consumption, 1.87 lb. per I. H. P. When this trial was carried out there was a heavy sea with ground swell in the Channel, "but it had no effect on the yacht," says the *Times*, "which, as on the last occasion, proved a thoroughly trustworthy sea boat. There was no perceptible vibration, and in the saloon it was difficult to realize that she was under way in a heavy sea." On the full power trial the yacht made four runs over a measured course off the Cornish coast and completed the eight hours steaming by going up the Channel full speed until the expiration of the time limit. During this trial the yacht drew 18 ft. 2 in. forward and 20 ft. 1 in. aft. The steam pressure carried on the boilers was 306 lb. Revolutions were 147.2 for the starboard engine and 147.6 for the port, and the vacuum 25.2 in starboard and 25.3 in port. The I. H. P. was 5,620 for the starboard engine and 5,678 for the port, or 11,298 collective. The mean air pressure was .6 in. and the mean of the four runs gave a speed of 20.53 knots. No record of coal consumption was kept, which is not to be wondered at considering the rate at the lower speeds.

With reference to the behavior of the yacht during the trials the authority already quoted continues: "The trials have been of especial interest from the constructor's point of view, for after the unfortunate incident at Pembroke some doubts arose as to her stability in a seaway; but fortunately these doubts have been entirely dissipated bv the behavior of the yacht in two gales, when her speed did not fall off to an appreciable degree, while in a moderate breeze she was perfectly steady. Whether she has had to steam through a heavy sea or through smooth water the bow wave has been clean and regular, with a fine run from the stem to the midship section, and no volumes of water of weight have been thrown off from any part. Nor has there been any churning or thumping under the quarter whether the ship has been traveling at her highest speed, or running through a gale. Each trial also disclosed an absence of vibration over the propellers, while the tests that were made in the worst weather she encountered showed that the angle of heel in rolling did not exceed eight or ten degrees. The hull and engines have thus answered all the requirements of the designers."

Private advices do not speak in such unqualified terms of praise of the new vessel, and it is generally understood she will be sent across the Atlantic to Nova Scotia to test her sea going qualities. It is not unlikely indeed that the members of the Royal household will need some special demonstration of her seaworthiness before they venture to risk a trip in the new *Victoria and Albert.*

Lightship No. 72.—The new United States lightship for the station on the Diamond Shoals, off Cape Hatteras, was launched at the new shipyard of the Fore River Engine Co., at Weymouth, Mass., September 10. She was christened by Miss Frances A. Killilea, of East Boston. This vessel is one of the new type of steam light vessels, so that she will be able to keep her station in all kinds of weather. Her dimensions are: Length, 112 ft.; beam, 28 ft. 6 in.; draft, 11 ft. 6 in.; displacement, about 600 tons. She will be fitted with three decks, one smoke stack and two beacon masts. The lights, of which there are three for each mast, will be fitted both for electricity and oil, the height of the light from the water line being about 60 ft. The electrical lightship equipment consists of six 100 c. p. 100 volt lights, the lighting of the ship being furnished by eighty 16 c. p. incandescent lamps. The propelling engine is of the single cylinder surface condensing type, of about 250 I.H.P., and is supplied with steam by two single-ended Scotch boilers built for a working pressure of 100 lb. The electric plant will be driven by two double-cylinder high-pressure engines. The vessel will also be fitted with a large Crosby chime whistle and powerful siren. Her construction is similar to that of the steam lightship which is now stationed at the South Shoal Station, off Nantucket.

American-Hawaiian S. S. Co.—The opening of the service of the American-Hawaiian Steamship Co., between New York, Pacific Coast ports and the Hawaiian Islands, which was intended to have occurred September 1, in the sailing of the S. S. *American*, from New York, has been postponed. The first vessel of the fleet to be completed, the *Californian*, was chartered gy the Government for service as a transport, and the S. S. *American*, which was intended to commence the service from here, is not yet ready for sea. The company has already secured docking facilities in New York harbor, at the foot of 42d street, South Brooklyn. The fleet of vessels will consist of the *American, Hawaiian, Oregonian, Californian,* each of 8,500 tons, and the *Alaskian* and *Arizonian*, of 12,000 tons. A monthly service will be maintained. The general agents of the company are Flint, Dearborn & Co., New York, and the Pacific Coast agents are Williams, Dimond & Co.

U. S. Submarine Boats.—Names for the six new Holland submarine boats for the Navy have been decided upon. The places of construction and contract time for the new boats are as follows: *Adder*, 9 months, Crescent Shipyard, Elizabethport, N. J.; *Gampus*, 8 months, Union Iron Works, San Francisco, Cal.; *Moccasin*, 9 months, Crescent Shipyard; *Pike*, 9 months, Union Iron Works; *Porpoise*, 10 months, Crescent Shipyard; *Shark*, 11 months, Crescent Shipyard.

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—I.

BY CARL BUSLEY.

Of all the branches of ship construction the ignorant have devoted most of their energy to the designing of submarine boats. According to my searches from the year 1861, in the former Prussian and the present German Navies, I have found not less than 181 different designs of submarine boats which have been submitted, whose designers were in all branches of business excepting that of ship construction. It is strange in searching over these papers to note that ministers, teachers, students, bank clerks, railroad employees and other people in the peaceable walks of life, as well as simple mechanics, have devoted their time to the designing of a death dealing submarine machine, which after particularly fantastic performances by diving, must sink at least six lines of battleships. The explanation for the great attention paid to the designing of submarine boats by landsmen and for the great interest which the public at large will always take in such apparatus lies, no doubt, in the fascination for horrors. Furthermore it is noticeable what little interest in construction of this kind has been taken by legitimate builders and designers in the different shipyards of all countries in former years. Latterly the navies of several countries have interested themselves in the question as to the outlook of the submarine boat in naval warfare and since then the builders have taken a more earnest interest in the different questions, so that it is possible to tablulate the different qualities and properties which the modern submarine boat requires. Submarine vessels can be divided into two large groups: No. 1, actual submarine boats which are intended to be entirely submerged; No. 2 partially submerged boats which remain very close to the surface and from which only single parts, such as the lookout tower, project above. The older boats are mostly of the first class and the boats of modern construction are of the second class. In order to further tabulate submarine boats they may be divided into two classes; (a) submarine boats with man power; (b) submarine boats propelled by machinery, although the boats propelled by man power, which could properly be called the pioneers, have not been built during the last thirty-five years, and therefore cannot be called modern boats. Nevertheless there are single cases nowadays in which man power is still employed.

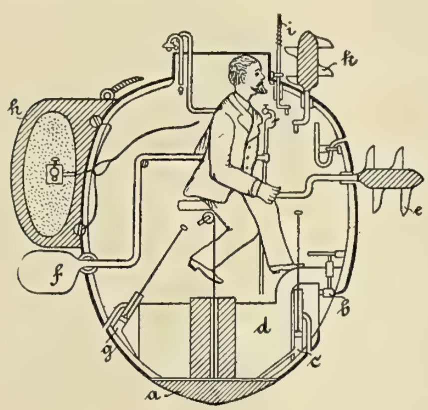
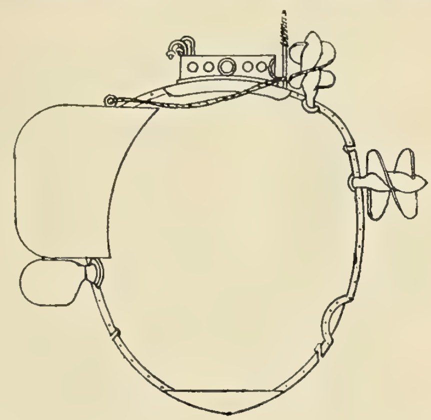


FIG 1.



BUSHNELL'S BOAT, 1775.

FIG. 2.

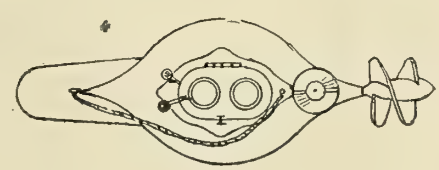


FIG 3.

CHAPTER I.

First Submarine Boats, 1604-1660.—The first attempts in the construction of submarine vessels, including the divers' bell which, of course, was known to the ancients, dates back some 300 years and appears in England at the time of the projected invasion from the great Spanish Armada. The project of the first boat of which anything definitely is known bears the date of the year 1604. It was designed by William Bourne, but was never built. The second submarine boat built of wood by Cornelius van Drebbel was tried on the Thames, in 1624, in the presence of King James I and numerous spectators. It had a capacity for fifteen persons, and was moved by means of twelve oars, which passed through the side by means of leather stuffing boxes. The boat, according to the reports, was completely submerged with its whole crew and the air in the boat was, according to the old reports, "kept pure by means of liquids." An Englishman named Day in the year 1660 remained under the water in his submarine boat at Yarmouth for a time of twelve hours, and came safely to the surface again. In his second attempt the boat sank slowly and never appeared again, and a prolonged search which was made with the frigate *Orpheus* was fruitless. The inventor as well as the rest of the crew were buried in the waves, hence none of the details of this craft remain; it is only known that it was similar to the Drebbel boat in the fact that it possessed a double bottom which could be filled with water and had to be pumped out to raise the boat. For the next 100 years all submarine boats were constructed on this principle until the Americans in

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.

the war of the Revolution took up the old ideas of the English.

CHAPTER II.

Bushnell's Boat, 1775.—At the breaking out of the war of the Revolution in the year 1775, David Bushnell, of Connecticut, built a submarine boat which, according to the sketches and descriptions, is reproduced in Figs. 1, 2 and 3. In appearance it looked like two turtle shells set back to back. It was built of wood and measured about 7 1-2 ft. dia. It carried only one man and had only enough air capacity for submersion of about a half hour. The boat was kept stable by attaching a lead weight at the bottom which could be detached by the operator at any time in order to come to the surface quickly. Furthermore there was a sea cock *b* and ballast pump *c* and tank *d*, and this, in addition to the vertical propeller *k*, enabled the boat to either rise or sink. Its speed must have been very slow as it was operated simply by a small propeller *e*, turned by hand and a small rudder *f*. The rest of the outfit consisted of the bilge pump *g*, to remove any water which may have leaked into the apparatus, a glass water gauge closed at the top and open at the bottom, in combination with a scale by means of which the operator could judge of the depth, a compass and also a torpedo filled with gunpowder and equipped with a time fuse, so arranged that it could be detached from the boat by the operator at any time. In the year 1776 it was reported that an officer by the name of Lee had made the attempt to attach the torpedo to the English blockade ship *Eagle*, of 64 guns, which lay in New York harbor. It was furthermore reported that he did not succeed in attaching the torpedo as the attaching screw of the same came in contact with some iron part of the ship's body, and when he attempted to get another position under the boat he lost his way under the water and had to discontinue his efforts at daybreak. On his return he feared that he had been discovered by the enemy and therefore disconnected the torpedo from the boat in order to lighten her and increase his speed. An hour after his return the mine exploded. The clock work in the mine was supposed to start at the moment of detaching and had been set for twelve hours. The assertions made by Lee could never be verified, and it is, therefore, very probable that right in the beginning of the undertaking he had cast the dangerous torpedo adrift, and then quietly waited on the surface of the water for daybreak.

CHAPTER III.

Fulton's Nautilus, 1797.—Robert Fulton, the builder of the first authentic steamboat, had, in the year 1797, designed a submarine boat in France. He laid the plans for the boat before the French Government, which refused to interest itself in the construction of the submarine boat. Not until the year 1801 could he perfect his boat *Nautilus*, after Napoleon had arranged to get him the necessary funds. The *Nautilus* had steel frames and sheet copper plating, as shown in Figs. 4-6. It was built in the shape of a cigar and had a length of about 24 ft., and a mean height of about 6 ft. When it floated on the surface it could be propelled by means of sails; when diving the mast was hinged downwards and, with the sails, was stowed in a groove in the top of the ship's body. Under water it was propelled by a screw which the crew turned by means of a crank. The diving and rising to the surface was effected by the filling or pumping out of water in the ballast tank, which was built in the bottom of this cigar shaped craft. In June, 1801, the *Nautilus* received a trial in the River Seine, Paris, and then was taken to Brest where the inventor, with three men, remained an hour under water at a depth of 24 ft. On August 7, 1801, Fulton remained under the water for four hours and twenty minutes. This was effected by taking a vessel of compressed air with them. He attached a mine to a hulk, and the mine was exploded promptly. Nevertheless the French Government, as well as the English Government, to whom he applied later on, decided not to follow up his idea.

CHAPTER IV.

Phillips' Boat, 1844.—In 1844 Lodner Phillips built a boat of about 10 1-2 ft. long, of elliptical section, in Michigan City. The boat was built of wood and on his first trial it collapsed at a depth of about 18 ft., and he himself narrowly escaped drowning. He built a second boat, 17 ft. long, also of wood and fitted it with a cylinder for compressed air and also certain spaces for water ballast, and continued his experiments. These gave him such satisfaction that in 1851 he built another cigar shaped boat about 38 ft. long and 4 ft. beam, and the wood hull of which was about a foot thick. In 1854 he took this boat to Lake Erie in order to dive down to the wreck of the steamer *Atlantic*, which lay in about 150 ft. of water. In the first attempt to lower the boat to this depth no crew were aboard, as they had grave fears of its strength. It collapsed and never came to the surface. In 1864 Phillips designed a craft, as shown in Figs. 7-10. This was intended for naval purposes and the United States Navy, as well as the German Navy refused to buy it. This boat was about 85 ft. long and about 8 1-2 ft. deep. It was built of 3-8 in. plate and had T iron frames, spaced about 18 in. To lower the boat and raise it to the surface he used ballast tanks which were filled with water and were emptied by means of compressed air. This compressed air was carried in the pipes shown on the upper side walls of the boat. In order to freshen up the air in the boat, the air pumps forced the foul air through a cylinder filled with water by which it was purified and the necessary oxygen was supposed to be supplied to it. It was intended to turn the screw of the boat by man power and to attain a speed of from four to five knots, which Phillips claimed he got out of his third boat in Lake Michigan with a power of four men. The reports of Phillip's trials in Lake Michigan are very meager, and it is, therefore, impossible to derive any data which would be of present value.

CHAPTER V.

Bauer's Boat, 1850.—On the 1st of February, 1851, the Bavarian artillery officer Wilhelm Bauer tried a submarine boat, Figs. 11-13, in the harbor of Kiel. An excess of pressure caused the boat to leak and it sank. It was not until nearly forty years afterward that this boat was brought to the surface again. At

the time the boat sank Bauer and two men were in it, but they were fortunate to escape with their lives, as the highly compressed air in the boat, caused by the leaks, forced the manhole off its seat and the three men shot to the surface in a huge air bubble. This boat of Bauer's was built in the machine shop of Schweffel & Howaldt in Kiel, and finished in December, 1850. Its length was 25 ft., beam 6 ft., and its greatest height 9 ft., with a total weight of about seven tons. It was built of 1-4 in. iron and with angle iron frames. The propeller was driven order to bring light into the boat a deck light was fitted above. In the forward part in addition to four deck lights it was fitted with two round openings which were equipped with rubber gloves attached by means of bronze stuffing boxes, so that a man could put his hand through in an attempt to perform certain work under water. By means of the hand wheel *f* Bauer moved the weight *g* backwards and forwards in the boat in a forward and aft direction in order to give the boat certain inclinations while under water. In regard to the weakness of the

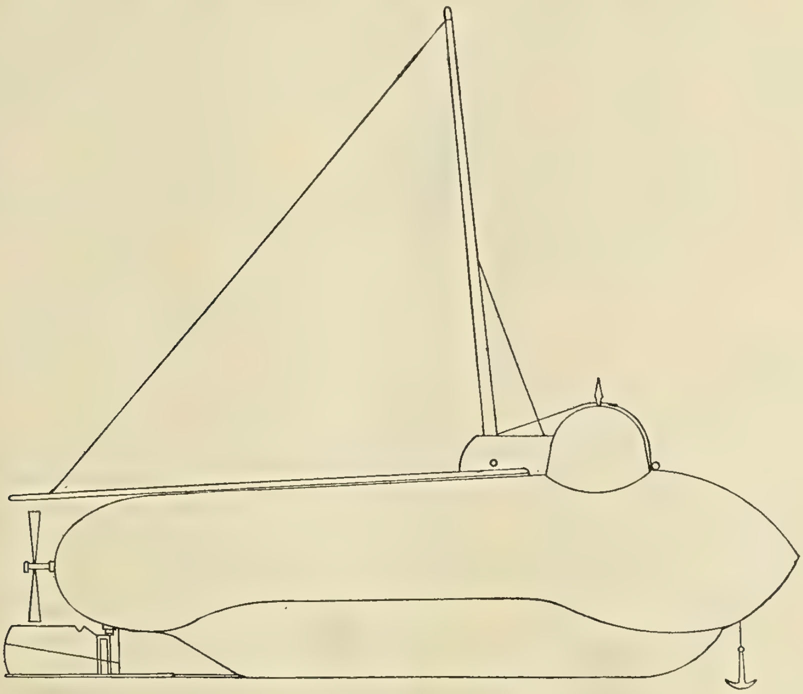


FIG. 4.

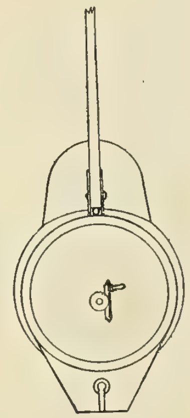


FIG. 5.

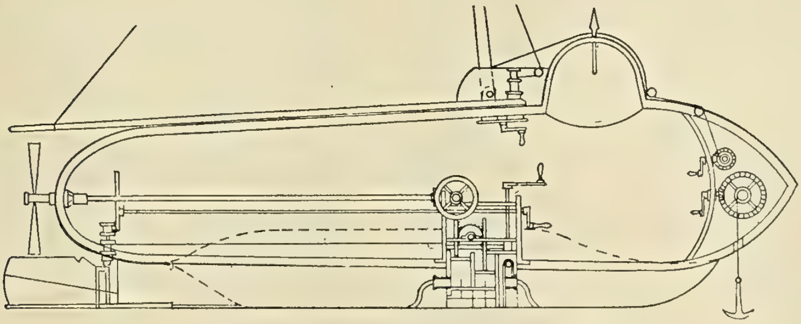
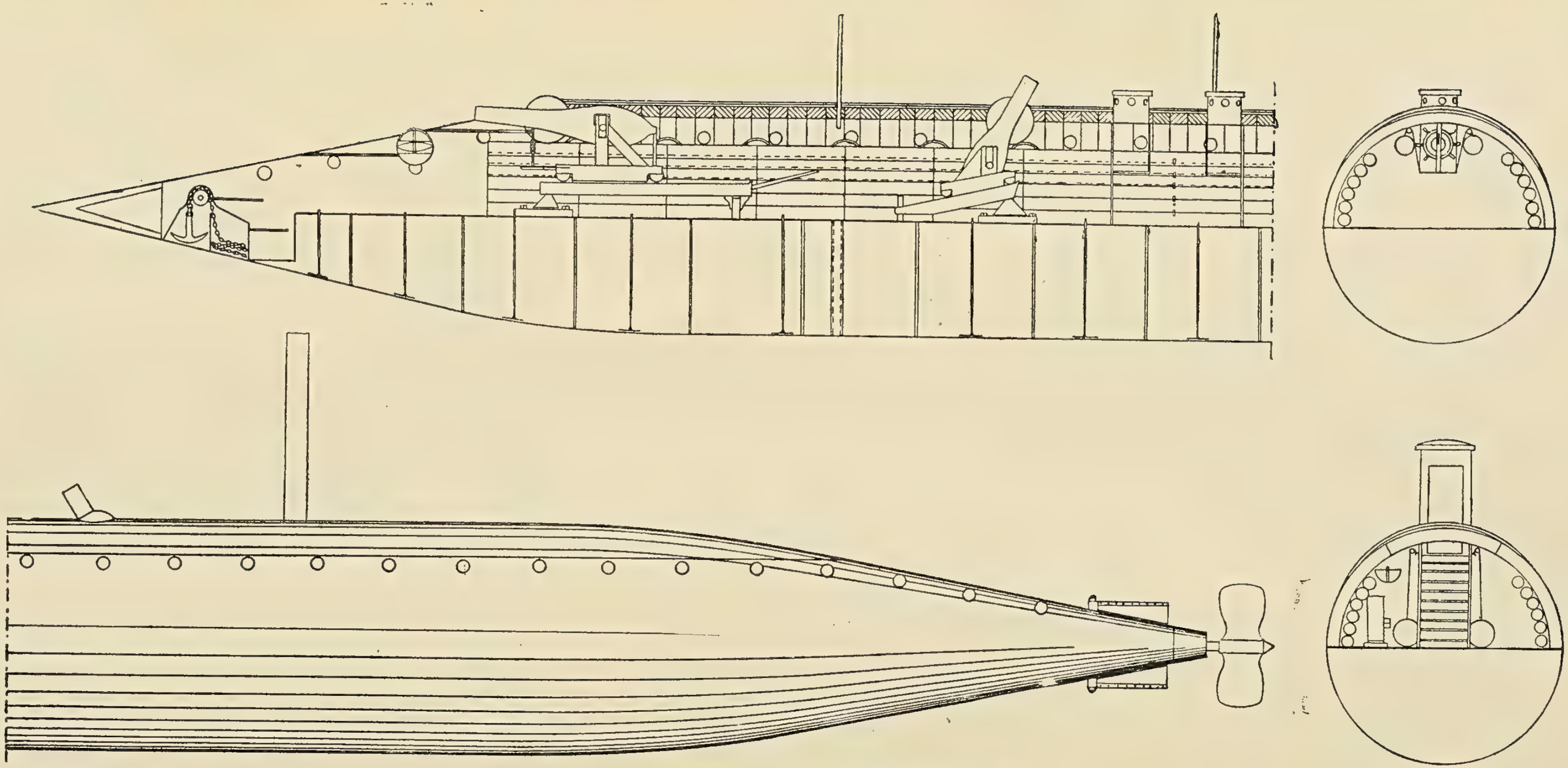


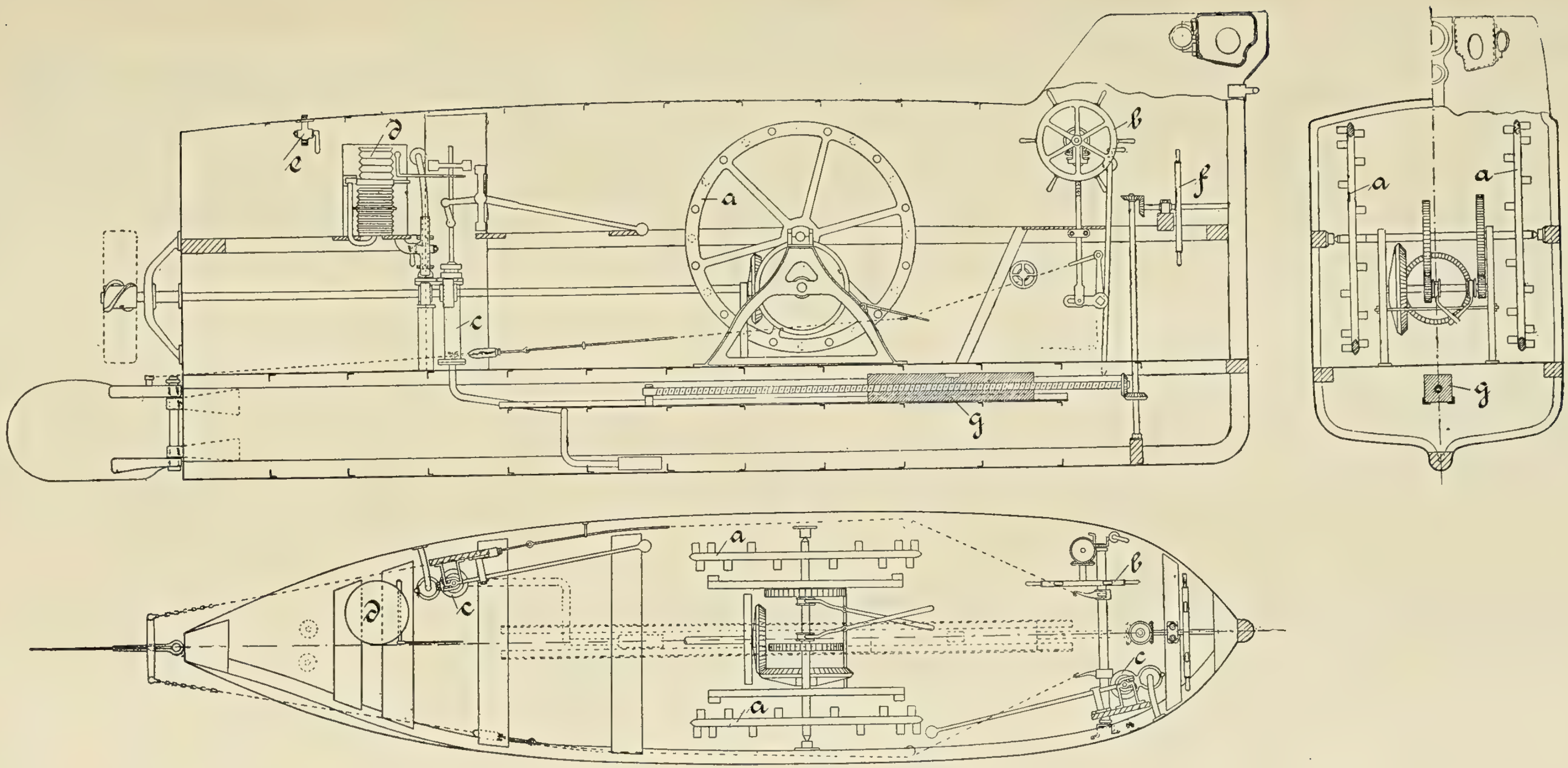
FIG. 6.—FULTON'S NAUTILUS, 1797.

by means of bevel gears which at that time were driven by hand weights, as shown in the engraving. While Bauer steered the boat by means of a hand wheel *b*, two pumps *c*, *c*, were fitted forward and aft. These were used for both ballast and bilge purposes; a bellows *d* was eventually used for the purpose of purifying the air by means of water let in by a cock *e*. In later trials which he made in St. Petersburg he attempted to purify the air by spraying the sea water into the boat. The bottom of the boat was fitted with twenty-two tons of pig iron to keep it stable, and in hull Bauer could not devote more material for strengthening owing to lack of funds. In October, 1855, Bauer built a larger submarine boat for the Russian Government in St. Petersburg, in length about 50 ft.; beam about 12 ft., and height about 12 ft. The propeller was driven by twelve men, and it required one additional man to steer. Taken all in all it was about the same as his previous boat, the only addition was that in the middle it was equipped with a peculiar air lock so that a diver could leave or enter the boat while under water. He also replaced



FIGS. 7, 8, 9 AND 10—PHILLIPS' BOAT, 1844.—SEE PAGE 406.

the iron ballast by water ballast which was kept in three cylinders, fitted with pistons. These pistons could be moved by means of screw gear and eject the water when they wanted to come to the surface. The first trials of this boat, which occupied a length of time of about six weeks, were made with reference particularly to the purifying of the air under water and a Russian chemist, Lenz Fritsch, was asked to assist. They succeeded in purifying the air by means of artificial rain, as well as by the introduction of oxygen gas which was carried in a compressed state in flasks. By this means, it is stated, that Bauer remained nineteen hours under water with twelve men. He stated that the Russian trials were entirely satisfactory in every way and that he himself failed, as a sacrifice to political intrigue. The official reports by the Russian Government, however, state that the time required for the boat to get 3 ft. under the surface was a half hour, and that a similar time was required to come to the surface and that furthermore when it was submerged it took the time of 17 minutes to go a distance of 300 ft. and that after having gone that distance the boat had to stop owing to the fact that the crew would be completely exhausted. The trials were continued during the years 1856-7-8 without any important additional results and after the Russian Government had thoroughly satisfied itself that the boat was unfit for naval purposes it made Bauer a present of it on the condition that he was not to take the boat away from Russia. Bauer again complained of his treatment by Russia. During the four years of trials he received a monthly salary of 180 roubles, and at the termination he received the vessel itself, which had cost 56,732 roubles. In order to realize



FIGS. 11, 12 AND 13.—BAUER'S BOAT. 1850.

on it Bauer had it broken up in St. Petersburg and sold it in parts. From March, 1863, to January, 1869, Bauer had an active correspondence with the Prussian Navy with the view of building a submarine cruiser of about 115 ft. length, 20 ft. beam and 10 ft. in height, whose principal weapon was to be a 150 lb. mortar, which was supposed to stand vertical. The Vulcan works of Stettin made careful estimates of this boat and reported that it would require 287,700 marks to build it. At first Bauer wanted to drive the boat by means of treadles; later on he intended to use compressed air, according to the system adopted by Bourgois & Bruns. Still later he proposed to use a "hydraulic rotating gas steam engine" about which the marine engine builders had grave doubts. Dingler's machine shop in Zweibrücken made preliminary trials with Bauer's "petroleum gas steam engine," and soon found out that such an engine was a great deal less economical than an ordinary steam engine; therefore, the trials were abandoned. The inventor, however, attributed this to the jealousies of the engineers, as he had done in other cases when the unpracticability of his ideas were presented to him. The general idea seems to have been that Bauer had been wronged, but the reports of the Navy show how his different ideas, starting with the submarine boat, submerged artillery, power machines and balloons were all formally tested by a commission of competent men who were always friendly inclined to him. The Government naturally could not take part in all of these unripe and improbable projects. It is not to be denied that Bauer, although a man of great activity, lacked technical training and knowledge of natural laws which would explain his self-assertion and optimism.

U. S. LAWS REGULATING THE IMPORTATION OF MATERIALS FOR THE CONSTRUCTION AND REPAIR OF VESSELS.

In the shipping trade legal questions regarding the importation of materials, etc., for use in the construction of repairs of vessels often arise. It is of interest, therefore, to note decisions and rulings which have been made in recent cases and which are accepted as the law at the present time.

It will be remembered that the liner *New York*, belonging to the International Navigation Co., lost one of her screws and tail shaft on a recent westbound trip and that the lost articles were replaced by spares stored in Southampton for use in such emergency and sent over here to be put into the ship at Newport News. No duty was paid on this machinery and the authority for this action of the custom officials is contained in the following opinion of the Attorney General of the United States which was rendered to the Secretary of the Treasury in a somewhat similar case which arose in the early part of last year. The opinion is as follows:

DEPARTMENT OF JUSTICE.

February 24, 1899.

SIR: In your communication of the 14th you submit the question whether you have the power to permit a piece of machinery known as a "screw boss" brought into the harbor of New York by the *Friedrich der Grosse*, for the purpose of replacing a defective piece in the steamship *Kaiser Wilhelm II*, of the same line—North German Lloyd—to be transferred in that harbor under proper safeguards from the former to the latter vessel without the payment of duty thereon.

It appears that the screw boss sought to be transferred is a duplicate piece of machinery, designed and made especially for the *Kaiser Wilhelm II* and kept on hand at the home port (Bremen) for use in case of emergency. Duplicate pieces of the more important parts of the machinery of this vessel were manufactured at the time of the building of the engines and machinery, and have been kept on hand since, so that in case of accident a broken or defective piece of machinery may be replaced without delay. The smaller pieces are carried on board the ship, but on account of its weight (6 tons) the screw boss was kept at Bremen until needed.

Under the circumstances stated I am disposed to regard this duplicate piece of machinery, not as an article imported from a foreign country and subject to duty under our custom law, but as a part of the equipment originally provided for and belonging to the steamer *Kaiser Wilhelm II*, which you may permit to be delivered to it by its sister ship without the payment of duty.

In the recent case of *The Conqueror* (166 U. S., 110) the Supreme Court held that a steam yacht built abroad and purchased by a citizen of this country was not subject to duty upon being brought into the port of New York. Respecting the question of this steam yacht, the court, speaking by Mr. Justice Brown, said, page 115:

"She is not imported or taken into the country in the ordinary sense in which that term is used with reference to other articles, does not become commingled with the general mass of property, and is employed precisely as she might be legally employed by her foreign owners, or by an American leasing her from such owners. Other articles are dutiable, not because they have been purchased, but because they are actually imported and become the subject of sale and commerce within the country."

In support of its view that a vessel is not dutiable, the court cited *United States* v. *A Chain Cable* (2 Sumn., 362) and *The Gertrude* (2 Ware, 181) involving the dutiability of parts of the equipment of a vessel, and therefore peculiarly pertinent in considering the question submitted.

In *United States* v. *A Chain Cable*, it was held that the chain cable which was purchased at Liverpool by the master of the ship *Marathon* to supply the place of a hempen cable which had become unseaworthy before the arrival of the ship at Liverpool, became a part of the equipment of the ship, and was exempt from duty, although after the ship had returned to Boston it was taken from the vessel and loaned for temporary use in launching a ship at Medford. Although attached from the ship while thus being used, it retained its character as a part of the equipment of the ship, and was therefore exempt from duty.

In *The Gertrude*, it was held that the tackle, apparel and furniture of a foreign vessel wrecked upon our coast, and landed and sold separately from the hull, were not goods, wares and merchandise imported into the United States within the meaning of the revenue laws. The case was put upon the ground that the rigging and apparel of the ship are a part of the ship, and therefore not merchandise in any other sense of the word than that in which the ship herself is. Judge Ware used the following language, which was approved by Mr. Justice Story on appeal to the Circuit Court (3 Story, 68, 71 76):

"If we look through the whole of the numerous acts of Congress laying duties on merchandise imported, as well as those regulating the question of the same, we shall find they uniformly contemplate the cargo; they refer to articles having the quality of merchandise in the ordinary and most popular sense of the word. They refer also to goods intended to be introduced into the country for sale and consumption, or for the general purpose of commerce."

I understand it to be true that under the ruling of your department, the racing rigging of a yacht which cannot be used in crossing the ocean, and is, therefore, brought back to this country on a steamer, is admitted free of duty because it is treated as a part of the yacht itself.

If the *Kaiser Wilhelm II* had itself brought the duplicate screw boss into the port of New York, the right to use it free of duty would hardly be questioned. The case is not materially changed by its being brought over in a sister ship and transferred in the harbor of New York, without any landing in the original sense. The duplicate

screw boss, like the original, was made and delivered abroad to the steamship company for the *Kaiser Wilhelm II.* It then became a part of the equipment of that ship, to be used when required. At present it is indispensable. It is not imported for sale or consumption here in the original sense. It is brought over to relieve the disabled ship of a friendly nation, detained in one of our ports for repair.

Upon the whole, without further discussion, let me say I take the view, you may permit the transfer and delivery to the *Kaiser Wilhelm II,* of this part of its equipment without exacting any duty.

Very respectfully,

JOHN K. RICHARDS, Solicitor-General.

Approved, JOHN W. GRIGGS,

The Secretary of the Treasury.

It is provided in Section 12, of the tariff act of July 24, 1897, "That all materials of foreign production which may be necessary for the construction of vessels built in the United States for foreign account and ownership, or for the purpose of being employed in the foreign trade, including the trade between the Atlantic and Pacific ports of the United States, and all such materials necessary for the building of their machinery, and all articles necessary for their outfit and equipment, may be imported in bond under such regulations as the Secretary of the Treasury may prescribe; and upon proof that such materials have been used for such purposes no duty shall be paid thereon. But vessels receiving the benefit of this section shall not be allowed to engage in the coastwise trade of the United States more than two months in any one year, except upon the payment to the United States of the duties of which a rebate is herein allowed: *Provided,* That vessels built in the United States for foreign account and ownership shall not be allowed to engage in the coastwise trade of the United States."

Section 13 further provides, "That all articles of foreign production needed for the repair of American vessels engaged in foreign trade, including the trade between the Atlantic and Pacific ports of the United States, may be withdrawn from bonded warehouse free of duty, under such regulations as the Secretary of the Treasury may prescribe."

Section 14 provides, "That all articles of foreign or domestic production needed and actually withdrawn from bonded warehouses and bonded manufacturing warehouses as supplies (not including equipment of vessels of the United States engaged in foreign trade, or in trade between the Atlantic and Pacific ports of the United States) may be withdrawn from bonded warehouses, free of duty or of internal revenue tax, as the case may be, under such regulations as the Secretary of the Treasury may prescribe; but no such articles shall be landed at any port of the United States."

It will be noted that these provisions of law are to be carried out under regulations to be provided by the Secretary of the Treasury, and in the new issue of such regulations which has just appeared the following provisions will be found:

"The word 'materials' as used in Section 12 may be understood as generally including all imported merchandise adapted for use in the construction of a vessel and of her machinery. Among the articles which would for the purposes of this law be regarded as 'materials' are the following: Lumber, timber, hemp, manila, copper and composition metal in plates or bars, iron and steel plates, anchors, bars, tees, bulbs, panel beams, rivets, rods, bolts, nuts and screws, rolled or forged bar plate, angles or bar plain finished or shaped, oakum, and cement.

"The word 'articles' as used in said section is sufficiently comprehensive to include everything which is suitable for use for the purposes set forth in the act.

"The equipment of a vessel is that which prepares her for a voyage, as rigging, sails, anchors, cables, chains, etc. The provision regarding 'equipment' does not cover articles used as 'supplies.' At the time of the withdrawal from bond of any materials or articles under said section, the person or firm withdrawing the same shall make oath, stating the purpose to which the merchandise is to be applied, giving the name and description of the vessel, the name and residence of the owner, and the place at which she is to be built or repaired. A bond will be required in the penal sum equal to double the duties on the full value of the merchandise. The above bond as well as the regular bond covering the original warehouse entry of the material so withdrawn will be canceled on the production of suitable proof of the proper disposition of the merchandise. The proofs include the oaths of the person who made the withdrawal, of the master builder and of the part owner or agent of a vessel, all of whom shall certify that the merchandise has been used entirely in the construction or repair of the vessel and for no other purpose."

Section 2,982 of the revised statutes also provides the privilege of purchasing supplies from public warehouses free of duty and shall be extended under such regulations as the Secretary of the Treasury shall prescribe, to vessels of war of any nation in ports of the United States which may reciprocate such privilege toward such vessels of war of the United States in its ports. Under this law the Secretary of the Treasury has decided that the privilege accorded by this section will be allowed to vessels of war of the countries hereinafter specified, it having been ascertained that a similar privilege is accorded by the Governments of those countries to vessels of war of the United States when visiting their ports, viz.: Austria, Chile, Corea, Denmark, England, France, Germany, Greece, Holland, Italy, Japan, Roumania, Sweden, Norway, and Venezuela. The regulations of the Treasury provide that when supplies are withdrawn from bond for the use of a war vessel, the withdrawal should be accompanied by a certificate from the commanding officer of the vessel, showing that the supplies are intended in good faith for the use of the officers and crew of the vessel, and not for sale; the supplies should also be loaded on board of the war vessel under the supervision of an officer of the customs, who will be required to certify that they were duly placed on board the vessel.

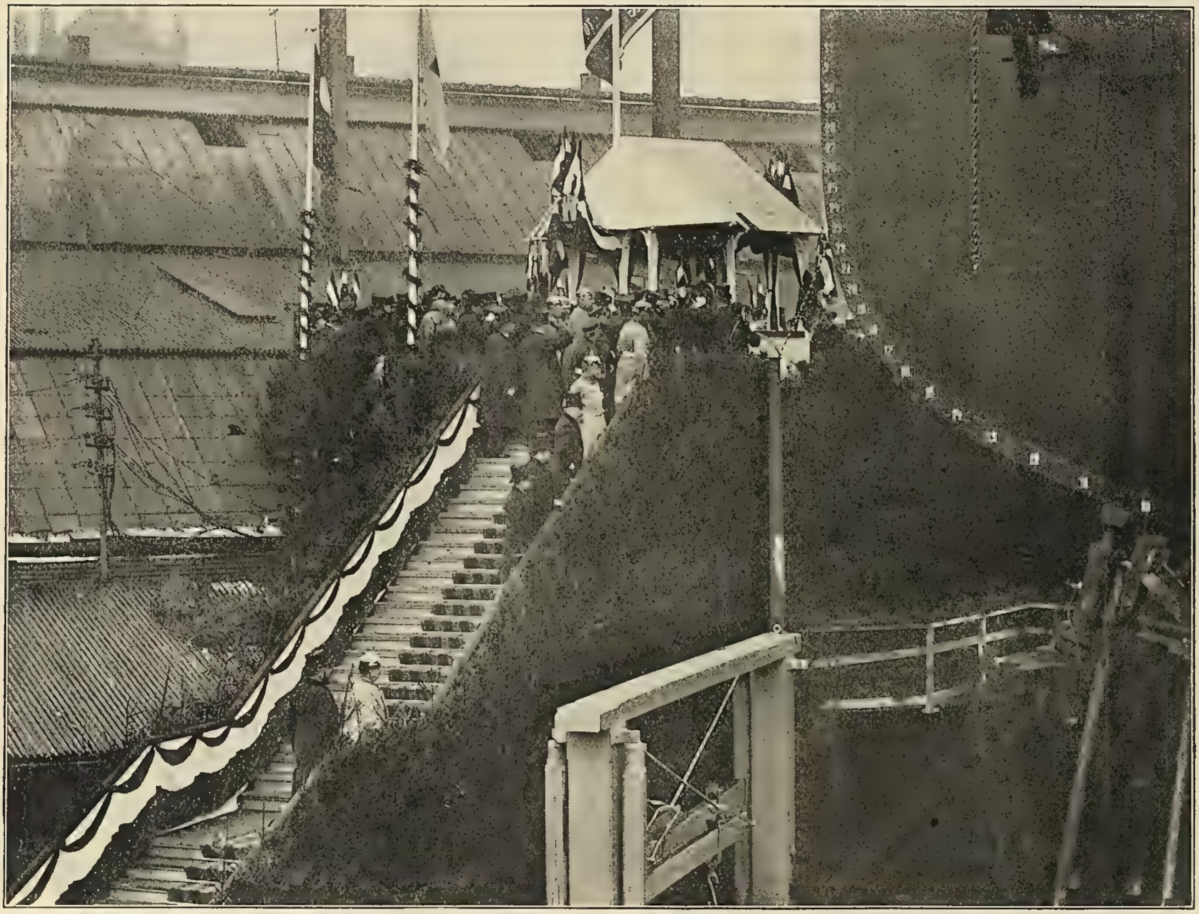
There is a provision in Section 3,114 of the revised statutes of the United States to the effect that the equipments purchased for, or repairs made in, a foreign country upon a vessel enrolled and licensed under the

laws of the United States to engage in the foreign and coasting trade on the northern, northeastern and northwestern countries of the United States shall on the first arrival of such vessels in any ports of the United States, be liable to entry and the payment of a duty of 50 per cent ad valorem on the cost thereof in such foreign countries. If the master of the vessel shall fail to make entry and pay duties as required by law, the vessel, with her tackle, apparel and furniture shall be seized and forfeited. There is a further provision in Section 3,115 of the revised statutes that any equipments or repairs in a foreign port which are absolutely necessary to ensure the return of the vessel to this country or to her port of destination, such as would be caused, for instance, by stress of weather or accident, shall not be subject to the provisions of Section 3,114. Under this law a number of United States General Appraisers recently decided that in the case of the steamer *Islander* the following expenses for repairs were within the meaning of Section 3,114, and that the vessel would be required to pay the duty of 50 per cent ad valorem on the cost of such repairs upon her arrival at Cape Vincent from New York to which she was bound. The repairs were: One smoke stack, $36.00; one crank pin, $20.00; carpenter work, $20.00; two iron shields, $3.00; soft patch on boiler, $157.00. Total, $236.00.

An honest difference of opinion as to "absolutely necessary" repairs might easily arise.

ADDITIONAL PARTICULARS OF THE NEW TRANSATLANTIC RECORD BREAKER DEUTSCHLAND.

It is evident that the new Hamburg-American liner *Deutschland* intends to come up to expectations in the matter of speed, for in an east bound run last month she eclipsed her best previous performances and incidentally made a new record. The new flyer passed the Sandy Hook lightship, bound out, at 1. 30 P. M. on September 5, and arrived off the Scilly Islands at 10.40 P. M. September 9, passing the Lizard at 12.35 A. M. on September 10. A short course, 2,982 knots, was covered, and the record time of passage was 5 days, 7 hours and 38 minutes. An average speed of 23.36 knots was maintained during the trip, and the daily runs were: 507, 535, 540, 549, 545, and 306 knots.



EMPEROR OF GERMANY AND GOVERNMENT OFFICIALS AT LAUNCHING OF THE DEUTSCHLAND.

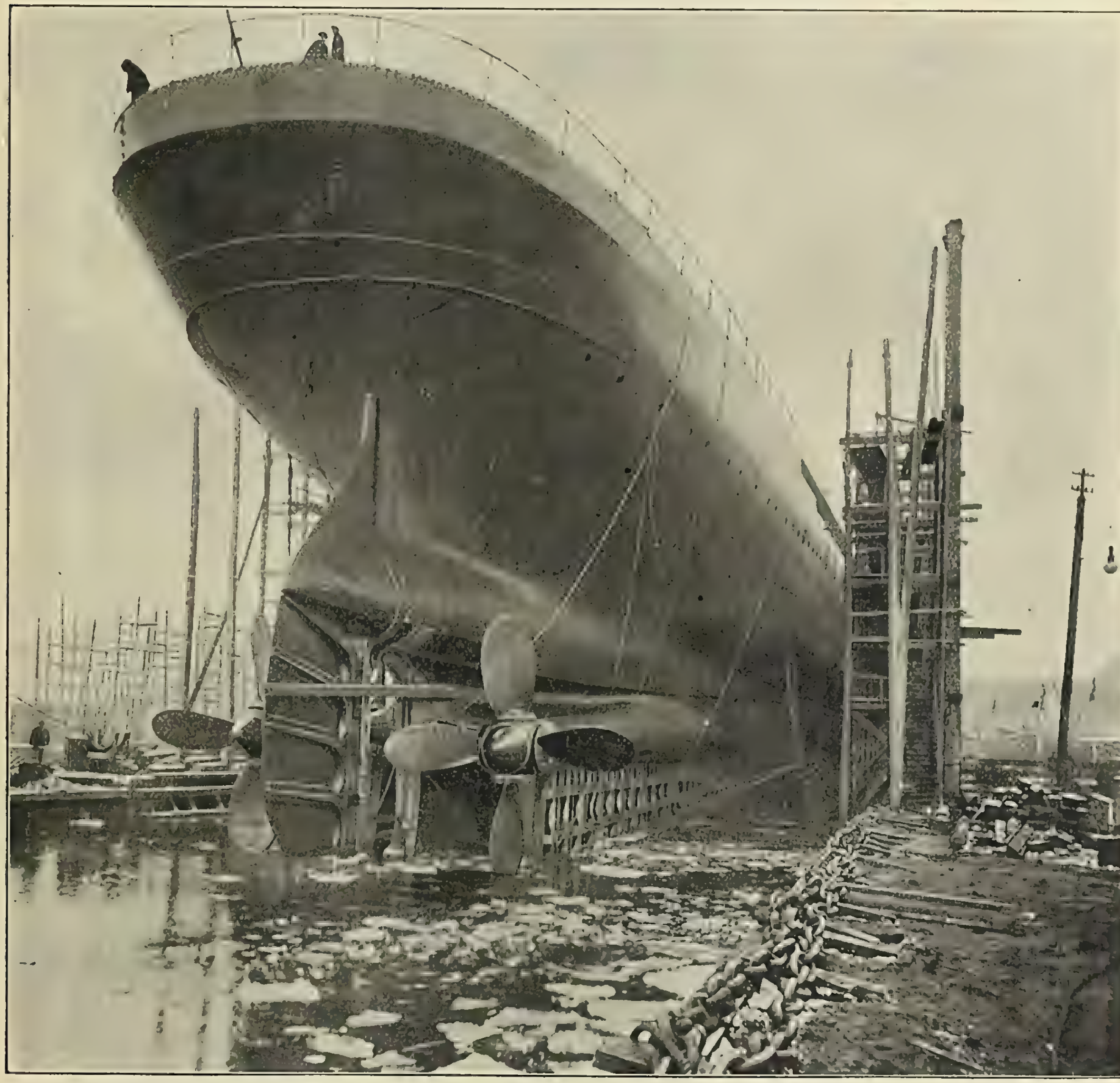
In our July issue we gave views of the engines and boilers of the new liner, as well as a general description of her machinery equipment, and we now supplement that information with detail dimensions of the machinery and interesting views of the hull of the vessel at the builder's yard. It will be remembered that the *Deutschland* was laid down with the view to service as an auxiliary cruiser in war time, and this accounts for many of the special details of construction. In the stern view the totally submerged rudder and the protection for the rudder stock will be no-

ticed. The propellers are carried close in and well under the hull, a large opening being provided just forward of the rudder after the fashion of a single screw vessel. Spare steering gear is also fitted below the water line and there are the usual cruiser gun platforms on the upper deck. Rapid fire guns with their mounts for the equipment of the *Deutschland* are to be ready at Hamburg and Kiel, so that at the briefest notice the vessel can be converted into a warship.

In construction the new liner meets, and in some instances exceeds, the requirements of the classification societies, and she is also fitted out in conformity with the German, British and U. S. Government rules.

For ready reference we hear repeat the general dimensions of the *Deutschland*. Length over all 668 ft. 6 in., between perpendiculars 662 ft. 9 in., beam mouded 67 ft., depth 44 ft., dead weight capacity 6,000 tons, gross tonnage 16,000 tons, displacement at 28 ft. draft 23,0co tons. On the maiden trip the maximum I. H. P. recorded was 36,600, but at the regular rate of revolutions, 78 per minute, 36,000 I. H. P. is said to be developed.

Siemens-Martin steel is the material used for the hull. This contains eight decks in all, viz.: Hold deck, steerage deck, main deck, upper deck, promenade deck, orlop deck, boat deck and sun deck. The steerage, main and upper decks run continuously from end to end. The launching weight of the hull exceeded 9,200 tons. In designing the vessel the question of subdivision was carefully considered and the ship has a cellular double bottom, divided into twenty-four tanks including the fore peak and after peak tanks. To take the drainage the usual number of wells are fitted. Under the boilers there are four ballast tanks which hold about 66,000 U. S. gallons of fresh water for extra boiler feed. The hull proper is divided into twenty-one water-tight compartments. A system of 8 in. piping connects the tanks and a duplex ballast pump located in the forward fireroom is



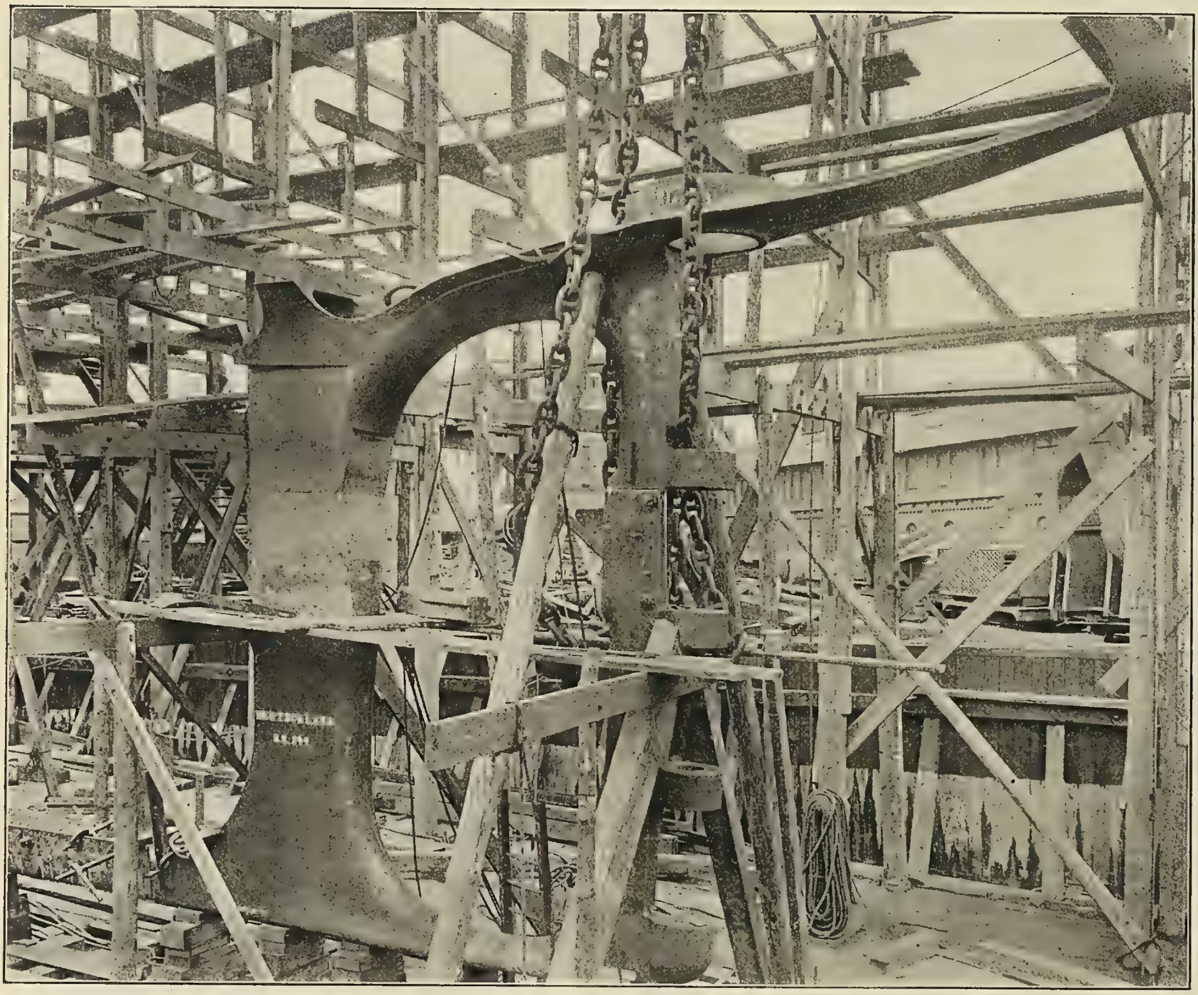
STERN VIEW OF T. S. S. DEUTSCHLAND TAKEN SHORTLY BEFORE THE LAUNCHING AT THE VULCAN WORKS.

capable of handling 280 tons of water an hour. This pump connects with all tanks and has also an outboard discharge. An auxiliary ballast pump with separate 4 in. system of piping is available in case the main ballast pump fails.

The engines, as our readers are aware, are each of the six cylinder, quadruple expansion, high-low tandem, four crank type, and are designed so as to reduce vibration, according to Mr. Schlick's patent system of balancing. The dimensions of the cylinders of each engine are: Two high pressure cylinders, each of 36.64 in dia., one first intermediate cylinder 73.67 in. dia., one second intermediate cylinder, 104.61 in dia., and two low pressure cylinders 106.38 in. dia. The common stroke is 72.89 in. All the cylinders are jacketed. Looking aft the sequence of cylinders is as follows: 1st crank, first intermediate; 2d crank, forward low and high pressure cylinders (tandem); 3d crank, after low and high pressure cylinders (tandem); and 4th crank, second intermediate. The crank shaft, illustrated in our July issue, is built up of four sections, and measures: length 59 ft. 33.8 in., outside dia. 25.2 in., weight 22,330 lb. The crank and propeller shaft forgings are of nickel steel made by Krupp in Essen. The main engine bearings have exceptionally large surfaces and are liberally proportioned.

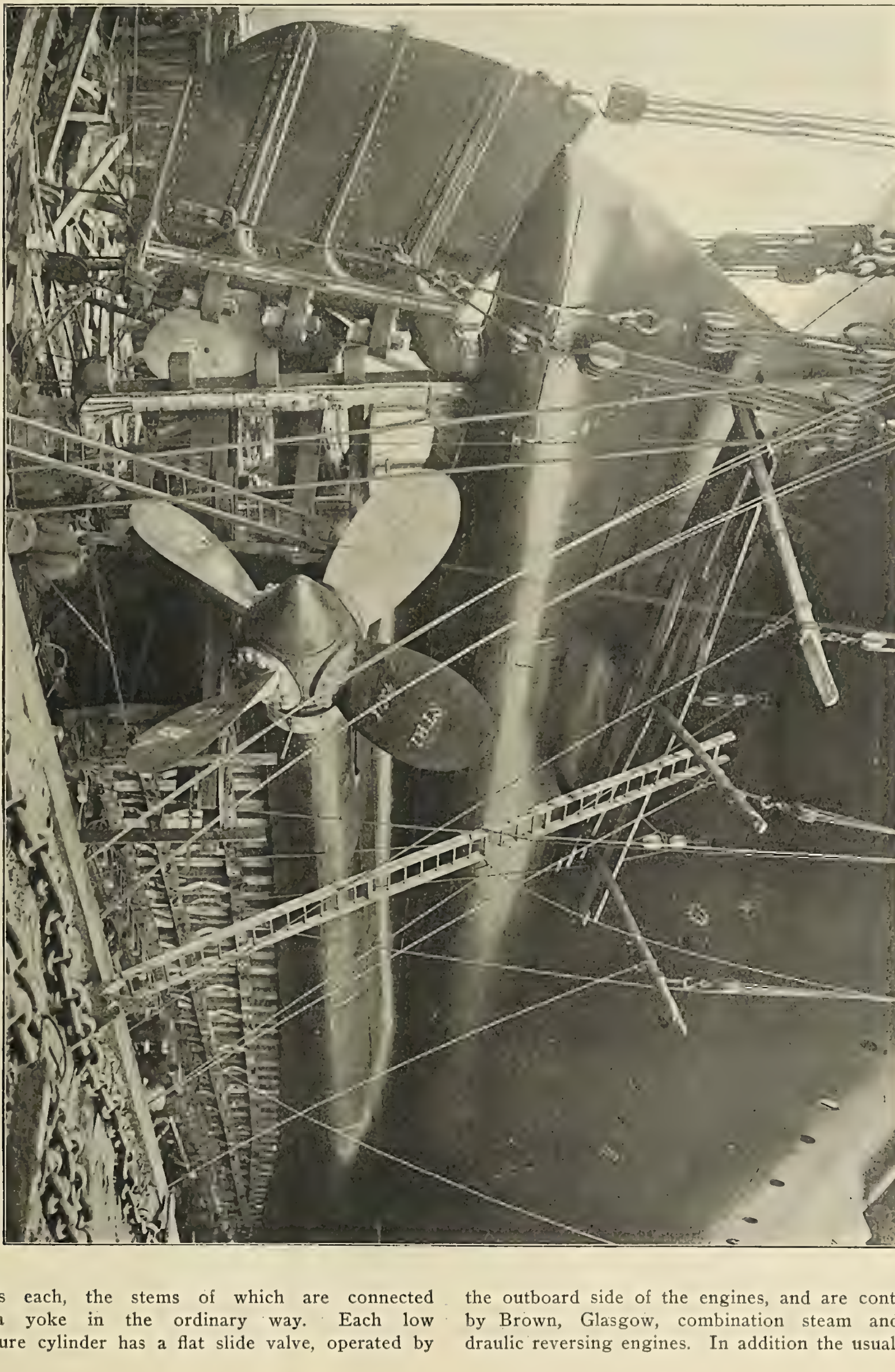
The engine framing is very similar to that of the *Kaiser Wilhelm der Grosse,* also built at the Vulcan Works. The frames are steel castings, sixteen in number for each engine, each frame receiving the horizontal thrust of a guide shoe from the crossheads. There are sixteen guide shoes for each engine, four to each crosshead, two for going ahead and two for going astern. The shoes are all of the same size, and are lined with white metal. The intermediate pistons are fitted with tail rods. The pistons are steel castings. The high pressure pistons are fitted with Ramsbottom's rings, the intermediate pressure with Buckley's rings, and the low pressure with Peck's patented rings.

The valves are worked by the ordinary Stephenson double bar links. The high pressure valves obtain their motion from a rocker shaft, which is placed upon the low pressure cylinder covers. One end of the rocker arm is attached by means of links to the valve rod, and the other end to a link rod passing between the intermediate and low pressure cylinders,



STERN FRAME OF T. S. S. DEUTSCHLAND SET UP ON THE BLOCKS.

and is attached to the valve gear below. The high pressure cylinders have one piston valve each. The intermediate pressure cylinders have two piston valves each, the stems of which are connected by a yoke in the ordinary way. Each low pressure cylinder has a flat slide valve, operated by two valve rods connected by a yoke. All valves except those of the high pressure cylinders are equipped with balance pistons. The weigh shafts are placed on the outboard side of the engines, and are controlled by Brown, Glasgow, combination steam and hydraulic reversing engines. In addition the usual hand



NEAR VIEW OF STERN OF T. S.S. DEUTSCHLAND, SHOWING DETAILS OF RUDDER AND PROPELLERS.

reversing gear is supplied. The turning engine is placed close to the main engine, and is of the ordinary double cylinder simple engine working a worm which engages the wheel on the main engine shaft.

Each engine room contains a main condenser of circular cross section. Condenser tubes are seamless, 3-4 in. dia., and tinned inside and outside. The total cooling surface for each main condenser is about 21,300 sq. ft. Each engine room also contains one independent air pump, built by the George F. Blake Mfg. Co. The pumps are of the vertical "Twin" type, double acting in the steam ends and with single acting water ends. The steam cylinders are 18 in. dia., water ends 44 in. dia., with a common stroke of 24 in. Cooling water to the surface condensers is supplied by two centrifugal pumps, both driven jointly by one compound engine. These pumps can also draw from the bilges. The discharge of the circulating water from the condenser is under the water line. Two double Weir feed pumps are fitted in each engine room, having steam cylinders 12 in. dia., and water cylinders 8 in. dia and 12 in stroke. The inboard feed pumps draw from the hot well and deliver the water into a Weir feed-water heater. The outboard pumps take the water from the heater and delivering the water through a Claussen, Glasgow, oil extractor, pump into the boiler feed line. Besides these connections the feed pumps can also draw from the fresh water tanks and pump directly into the boilers or overboard. The steam used for heating the feed water is taken from the second intermediate receiver and the auxiliary exhaust.

A Morrison radial type evaporator is used for making fresh water. This evaporator is capable of delivering about 23,770 U. S. gallons in twenty-four hours. The vessel is also fitted with an auxiliary condenser for use in port. The condenser has 861 sq. ft. of cooling surface. Condensing water is furnished by one auxiliary centrifugal pump. When this condenser is used at sea circulating water can be furnished by the main circulators.

The main boilers are sixteen in number, twelve double ended and four single ended. They are placed in four groups of four boilers each, viz.: three double and one single ended in a group. Each group of boilers has one smoke stack, making four stacks in all. The dimensions of the double ended boilers are: Outside dia., 16.58 ft.; length, 20.33 ft. They are each fitted with eight of the Morison type of furnaces, each 3 1-2 ft. dia. Steam pressure carried is 220 lb. Total grate surface of all boilers is 2,200 sq. ft. and total heating surface 84,250 sq. ft. The diameter of the tubes is 3 in. and all are supplied with retarders. There are 112 furnaces in all. Howden's system of hot forced draft is used, air being supplied by fans driven by compound engines. The arrangement for each group is somewhat novel. Two fans, 84 in. dia., are placed on top of the double ended boilers of a section, while the engines are over the single ended boiler in the same section and are directly connected to the fans by means of a long shaft.

There are two Blake simplex pumps 12 in. by 12 in. by 16 in., capable of pumping from the sea, the bilges and the double bottoms, and discharging overboard or into the fire mains. Each of the four boiler sections contains one Blake vertical duplex auxiliary feed pump, size 12 in. by 8 1-2 in. by 12 in., capable of feeding the boilers of that section. The pumps have connections which enable them to draw from the sea, fresh water tank, from the boilers and from the bilges, and discharge overboard or into the boilers. Water to the sanitary system is supplied by two Blake vertical simplex pumps, size 12 in. by 12 in. by 16 in., and also by two pumps directly connected to the main engines.

The thrust shafts 25.2 in. dia., are placed immediately aft of the main engines, and each shaft has twelve thrust collars. The thrust blocks are of the ordinary horse shoe pattern, with white metal facings and supported in the usual manner.

The entire line shafting is carried inside of the hull extensions, according to the Lundborg design. The line shafting is 25.2 in. dia., and the entire length of each set of shafting is about 215 ft.

The propellers are four bladed with bosses of cast steel and blades of Parsons manganese bronze. The diameter of the propeller is 23 ft. and the pitch adjustable from 33 to 36 ft.

Great attention has been paid to the sanitary arrangements, the bath-rooms being thirty-three in number, of which sixteen are first class, six for the suites, six second class, one for the captain, two for the engineers, and two for the hospitals. The electric lighting plant consists of five direct connected dynamos, of which three are of 700 amperes and 110 volts, and two are of 400 amperes and 110 volts. The two-wire system is used. There are about 2,000 lamps in the circuit. The electric engines were built by Dasvel, of Kiel, and are run at 250 revolutions per minute. The plant was installed by the Algemeine Electrische Gesellschaft, of Germany.

The refrigerating machinery is placed between the two propeller shafts, and consists of carbonic acid gas machines.

The number of life boats, all of which are carried on the seventh or boat deck, is twenty-six, of which eighteen are metal life boats of the Francis patent, two are wooden, and six are of the collapsable type.

The vessel, besides having the ordinary mechanical telegraphic connections, is fitted with a complete system of telephonic connections, thus enabling the officers on the bridge to be in verbal communication with the engine room force and the steering engine room crew.

The *Deutschland* is strictly a passenger vessel, the freight accommodations being very scant. Provision has been made for 470 first class, 300 second class, and 300 steerage passengers. The crew numbers about 430, all told.

U. S. S. Oregon.—It is reported that the injuries sustained by the battleship *Oregon* are much more serious than was at first supposed. In many places the outer bottom was ripped open, and the repairs which were carried out were of the most temporary character. It is probable that the vessel will be patched up at Hong Kong so as to come home for thorough repairs.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.*—II.

BY LIEUT. R. H. JACKSON, U. S. N.

PRACTICE ABROAD IN TORPEDO BOAT CONSTRUCTION.

In 1878 and 1879, England, Germany, France, and the United States built one or more fast launches of 60-100 ft. in length, and as high as 22 knots speed, to be fitted with Whitehead torpedoes. During the next five years, two or three 100-ft. boats were turned out by Thornycroft and Yarrow, principally to fill the orders of the leading foreign governments.

Germany.—In 1883 Germany decided upon a type of boat which was about 125 ft. long, 85 tons displacement, 1,000 I.H.P. and 19-22 knots, armed with two H. R. C. and two tubes. In the next seven years she added 63 of these to her flotilla.

In 1892 she built sixteen boats, 144 ft. long and 110-125 tons displacement, speed 25 knots; and in 1898 with 152 ft. length, the displacement was increased to 140 tons, apparently to obtain greater endurance, seaworthiness, and habitability. Her policy until 1898 had given her but two types of boats, sixty-three of the 125-ft. length (19-22 knots), boats distinctly for station work, and sixteen about 125 tons (25 knots), boats for operating with squadron.

In 1898 the size increased to 140 tons, and there are now building eight of 155 tons displacement.

Conjointly with the building of these boats, Schichau has built eleven larger boats, known as division boats. They have been added in the proportion of one to each seven boats, and are supposed to be the flag boats of the divisions, as well as to render aid, to a certain extent, to the other boats. They are between 250 and 300 tons, speed increasing from 21-28 knots, according to the date of building. Only the last of these boats, No. 11, has twin screws; while of the eighty-five torpedo boats already mentioned, none have twin screws. The armament of these boats, originally two 37-mm. guns, has now been replaced by 3-pdr. R. F. G. and .31 cal. machine guns, with two or three torpedo tubes, according to their displacement.

There are also twenty boats built by different firms between 1884 and 1887 that are less than 100 tons, and have twin screws.

England.—England was conservative, as usual. Her pioneer private firms were selling boats abroad before she began to build; but with her liberal appropriations, she has carried the boats forward more completely than any other nation. The history of her policy will consequently be the most instructive.

Starting with 86-ft. boats in 1878, she seemed content with watching the results of the efforts of her builders to fill the orders for one or two boats for foreign governments, till in 1885 she ordered the *Swift*, 150 ft. long, as the first attempt to get a sea-going boat. In 1885-86 she decided upon a type close to the type selected by Germany two years before, *i. e.*, 125 ft. long, with somewhat less displacement (60-75 tons), and ordered fifty-seven to be built at once.

The next year, on account of gradually increasing speed obtained by several firms, she built a boat 135 ft. long, with speed of 23 knots. In 1887, Yarrow sold a 140-ft. boat, speed 25 knots, to Spain; and Thornycroft a slightly smaller boat, speed 26 knots, to Italy.

In 1893-95, England built ten boats 140 ft. long and 100-130 tons displacement, which she tested the next year in her squadron maneuvers as well as her seventy small station boats about 125 ft. long.

These ten were the last torpedo boats built by her, the destroyer having replaced that sea-going boat for service with the fleet, leaving her ten sea-going station boats of the first class, and seventy-five vedettes for harbor defence.

Destroyers.—On account of the unsatisfactory speed of her torpedo gunboats, England, whose rôle is to protect the fleet, ordered (1893-95) thirty boats called destroyers, the rôle being to supplant the gunboat in protecting the fleet from torpedo attack; and further, having sighted the torpedo boat, to overhaul and destroy it. Thirty were built immediately, 190-200 ft. long, 220-280 tons displacement, and 27-29 knots speed. Seven slightly larger boats were built the same year, length 210 ft., displacement running up to 300 tons, and speed to 30 knots.

In 1895, during the squadron maneuvers, these destroyers were tested with such satisfactory results that England has made no addition to her torpedo boats since that time, but has increased her destroyer flotilla from 50 in 1895 to 118 in 1900, the only change in type being an increase in size and power. One of her latest laid down is as follows: Displacement, 420 tons; I. H. P., 9,000; speed, 33 knots; armament, one 12-pdr., five 6-pdrs., two tubes and four torpedoes.

Among the tests in 1895 was one to prove the power of the destroyer to catch the torpedo boat. Without any preliminary notice, twelve of the best torpedo boats, with a speed of about 20 knots in a smooth sea, were sent at full speed toward port 40 miles distant. After giving them twelve minutes' start, the destroyers were sent after them. The chase was over in eleven and a half miles, and lasted about thirty minutes. Four of the boats escaped, the highest speed logged by them being about 20 knots. Some of the boats broke down, as did two of the destroyers.

Good results with the destroyers were also obtained in firing at a target when running by at a 30-knot speed, and in discharging the Whiteheads when running from 20 to 30 knots. Experiments were also made as to the ability of the destroyers to block all the boats in port, and protect a fleet passing along a hostile coast. The results of most of the work in 1895 were kept confidential, but an extract from a letter written by a capable naval officer who took part in the operations says: "The impression left on my mind by the maneuvers was, that all the present types of boats are obsolete, and that probably no more (like them) will be built. But I believe that boats of the size of the destroyers will take their places in every navy." This certainly has been the policy of Great Britain. In 1896, in addition to the fifty already turned out of 27 knots, she laid down thirty more similar to the seven already noted, of 300 tons displacement.

FRANCE.—TORPEDO BOAT POLICY.

France in 1878 began with an 86-ft. torpedo boat of 30 tons and 19 knots, about like the *Stiletto* in our ser-

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

vice, but slightly smaller. In five years she acquired about fifty of these, and has built no more. When new they made from 16 to 19 knots. Her vedette boats—thirteen, including seven aluminum boats of 60 ft. and 15 tons displacement—she has shown no desire to increase. The first type (ten) she armed with 37 R. C., and on the remainder she has placed two 1-pdr. R. F. guns, and two torpedo tubes. This is now her armament for all boats except her sea-going boats.

While she was building her 86-ft. boats, third class, she also (in 1878-83) turned out eighteen 110-ft. boats, about the size of the *Gwin.*

In 1885, she made a large program for accession to her torpedo boat flotilla, and in the next four years added sixty to this *Gwin* type, though 15 ft. longer, and of somewhat less beam. All of her boats to this point were second-class boats, having less than 60 tons displacement with over 100 ft. length. At the same time a program was brought forward for building a certain number of boats of tonnage between 60 and 100, and length exceeding 100 ft. These were to be designated as first-class torpedo boats.

The type selected had the following characteristics: Length, 134 ft.; beam, 11 ft.; depth, 7 ft.; tonnage, 67, and I.H.P., 700, to give 20 knots with single screw.

From the experience obtained from these new boats a new type of first-class boat was adopted two years later, with the following characteristics: 118 ft. long, 13 ft. beam, 8 1-2 ft. draft, 79 tons, 1,300 I.H.P., 23 knots with two screws. The modifications in general terms being as follows: Adding a second engine of same size, thereby doubling the I. H. P., and giving a speed of 23 knots instead of 20. The boats now being 16 ft. shorter, 2 ft. more beam, 1 1-2 ft. more draft, on about 12 tons more displacement. This seems to have been satisfactory to the authorities for station work, as they were gradually added until in 1896 there were sixty-four of them practically identical.

In the armament of these boats she has been consistent.

The construction of sea-going boats began in 1889. In 1895 the *Forban*, built by Norman, led the world with 31.5 knots. During this time she built thirty-four 100 to 150 ton boats, length 140-160 ft., with every apparent variation in speed, armament, and coal endurance, without regard to dates of building. The armament varies from two 1-pdrs. to three 3-pdrs., this last battery being put on the smallest of the class, and the tubes varying from two to four.

Summary.—(*a*) Briefly outlining the results of France's torpedo policy, it is seen that commencing in 1878, she built second and third-class station boats, possessing, in 1885, fifty small *Stilettos* and *Gwins.* She then abandoned her *Stiletto* type, and in the next four years added sixty to her *Gwin* type, though 15 ft. longer and somewhat narrower. At the same time she made her first attempt with a first-class boat, *i. e.*, 60-100 ton boats, and laid down ten resembling the *McKenzie*, but 43 ft. longer and of a little less beam. These were evidently failures; for shortening the length 16 ft., increasing the beam 2 ft., and using twin screws, she has reached her present type, which will be referred to as the French station type.

She seems to have been unable to decide upon a sea-going type.

Her present flotilla comprises fifty *Stilettos*, seventy-five *Gwins*, and ten *McKenzies*, none of which types she would duplicate. Also sixty-three first-class, and thirty-five sea-going boats, of 120-130 tons of questionable sea-keeping power. It may be safely assumed that none of these are capable of remaining and operating with the fleet, but must always rest on a station as a base.

(*b*) Germany seems to have obtained a good type in her sixteen boats of 125 tons design, their principal objection (a bad one, however) is that they have single screws. Any boat required to operate at sea, more or less independently, must have two engines to insure her safety. A torpedo boat comes into port under one engine far oftener than is supposed.

(*c*) England's last sea-going torpedo boats (ten), built in 1896, about the same size as Germany's (110-130 tons) boats, but with twin screws, were satisfactory, but had not the sea-keeping power demanded by her policy, nor could they fulfill the tactical demand for the destruction of the enemy's boats, called for in her offensive rôle. Hence her destroyer.

France, ever trusting in her ingenuity and theoretical schemes, which lean toward the performance of miracles, has now directed her attention to submarine marvels, after having created an enormous flotilla of small boats, practically none of which are sea-keeping.

Conclusion.—From all this we find that a good twin-screw, sea-going, but not sea-keeping, boat can be obtained between 110 and 130 tons, while the destroyer must be over 250 tons, with a tendency to increase its size. England's largest destroyer, the *Express*, is 420 tons and 9,250 I.H.P.

Having looked over the navy list of the leading powers of Europe, it is seen that they have quite as heterogeneous a collection of boats as are shown on our own list, with the difference that they have large groups of each. This does not mean that they have found a need for each group, but rather that they represent the costly steps leading to present practice. The present practice shows but little variety in types.

These then are the types that foreign practice would lead us to adopt. After considering the information from the other two sources, we will compare them.

Secondly.—The performance of our own boats during the Spanish War.

As the boats made no torpedo attack, the principal points upon which information can be gathered are, habitability, seaworthiness, sea-keeping power, and durability. An investigation of these points will divide the boats into station and sea-keeping boats, and, in addition, the destroyer class. A brief record of the performance of the different boats that took part in the Spanish War will be given, starting with the smallest of the class.

The *Gwin* and *Talbot*, sister boats of 46 tons displacement, one engine, one boiler, and speed 20 knots, arrived at Key West the middle of July, having come down through the canals as far as Ocracoke Inlet. The *McKee*, a boat of the same class, except that she is equipped with two boilers, came at the same time. About the first of August, in response to the restlessness of their commanding officers, they were sent out on the blockade off the north coast of Cuba from Cardenas to Cay Frances. Their special function was

to pass in among the shallow inlets behind the Keys and capture and destroy all cargo boats, sloops, schooners, and fishermen, suspected of rendering assistance in discharging the cargo of blockage runners. The steamers entering these ports could not get up to the towns for lack of water, yet could remain concealed behind some of the Keys till discharged. The *Foote* and *Cushing*, 140 and 105 tons respectively, twin screws and two boilers, were also on this expedition. It was expected that large ships of the blockading squadron would be found in the neighborhood; from these supplies were to be drawn, and upon them they could depend for defence from the Spanish gunboats, of which there were several in the principal ports. These parent ships turned out to consist of one or two auxiliary converted yachts that were but poorly equipped with coal and water; and even they were soon separated from the boats. The *Talbot* having smashed in her bow in a night collison while carrying dispatches, the other boats cruised in pairs among the Keys, chasing and capturing all the craft that dared to appear, even in sight of gunboats, that usually contented themselves with pouring dense volumes of smoke from their funnels upon sighting the torpedo boats. The gunboats ordinarily lay alongside of the docks, content to be let alone.

On this cruise, one of the torpedo boats, having but a single boiler, was troubled with a leaky tube. So, lying under Piedras Key, she cut out and replaced the tube, and brought in boats enough water from a cistern on that island, to again fill the boiler. Just how long these little craft could have remained on this sort of duty it is difficult to say, as any passing vessel could supply them with coal and water, and a little hard bread and canned meat. When they returned from the blockade on the 10th of August, the preliminaries of peace having been arranged, they could certainly have remained a week longer without any additional supplies.

These boats then showed their ability not only to operate from a fixed base, such as Key West, but also to utilize the larger vessels on the blockade as a base, and efficiently carried out the rôle of shallow-draft gunboats is passing among the keys and suppressing all commerce across the interior waterways, though they were never designed for this work.

Cushing, Ericsson, and *Morris*. These somewhat larger station boats did not have very much duty during the war. The *Cushing* and *Ericsson* saw such very hard dispatch duty just before the war, as to necessitate very extensive repairs. The *Cushing* accompanied the other boats on the blockade on the 1st of August, and stayed out until the boats were recalled from the blockade. The *Ericsson,* though constantly breaking down and returning to port, scored a point in being the only torpedo boat on the scene of action on the day of the Santiago fight. This was due more to the ingenuity, patience, and perseverance of her commanding officer, than to any good quality of the boat. The *Morris* did not arrive till near the end of the war and did not leave Key West.

The *Foote* and the *Winslow* went out on the blockade of Matanzas, Havana, and Cardenas, at the outbreak of the war. The *Winslow's* career was about finished on the 10th of May, when she was disabled by the gunboats at Cardenas. She had seen several days of service on the blockade up to this time.

The *Foote* remained on the blockade for about seven weeks, coming in twice for mail and dispatches and fresh food for herself and the other ships occupying that station. She was then withdrawn, being relieved by the *Leyden.* After about two weeks' overhauling at Key West, principally renewing the boiler fronts, she was again ready for work, but was not sent out again till August, when she returned to the blockade of Cardenas and ports to the eastward, as already stated. She remained there till recalled at the end of the war.

Porter and *Dupont.* These two boats were at Key West at the outbreak of the war. They went on the blockade as did all the others. But the *Porter* was then assigned as a dispatch boat to the *New York,* and the *Dupont* soon returned to Key West, where she was held in reserve by the station ship for dispatches. The *Dupont* made two long trips, accompanying a squadron to Cienfuegos, and going out to meet the *New York* on another occasion. She was also at Guantanamo at the end of the war. Her record for steaming during the war was about 9,000 miles.

The record for staunchness, sea-keeping power, and general excellence belongs to the *Porter,* which held the record of 12,900 miles of war service, on dispatch and blockade duty, without other repairs than those made by the force on board. About the 20th of July she went north for general repairs, and a complete overhauling, her boilers having reached their limit of endurance.

Thirdly.—Strategical and tactical demands.

The West Indies has ever furnished a battle-field for naval wars; and so will it be in our next war. The importance of being able to control its waters will be doubly accentuated by the need of controlling the Nicaragua Canal.

Destroyers.—The fleet of battleships must be maintained in these waters, and their safety from torpedo attack by the enemy must be insured by the destroyers. So that a flotilla of these in the proportion of two for each battleship would be a fair allowance. They must possess the speed sufficient to catch a 25-knot torpedo boat, and the sea endurance to remain with the fleet without being a constant source of anxiety to the commander-in-chief. A small, but powerful battery, and comfortable quarters for the crew are the chief essentials. Two torpedoes furnish a sufficient armament to give all of the moral effect of the torpedo boat. Moreover, two torpedoes carefully fired, would be as good as half a dozen.

Sea-Keeping Torpedo Boat. In addition to this flotilla of destroyers associated with the fleet of battleships, the commander-in-chief needs an offensive weapon that can be used against the hostile squadron which may be operating in some portion of the West Indies, or is making a feint at some point along the coast. This may be only a detached squadron; yet something must be done to meet it.

Twenty sea-keeping torpedo boats such as the *Porter* can be made to cover long distances at good speed, without being seen; make an attack and disappear, leaving the enemy in such a demoralized state that they will fall back on their base, or at least withdraw from that vicinity. Their employment as mounted infantry

and light artillery combined would, in the hands of an energetic commander-in-chief, be most demoralizing.

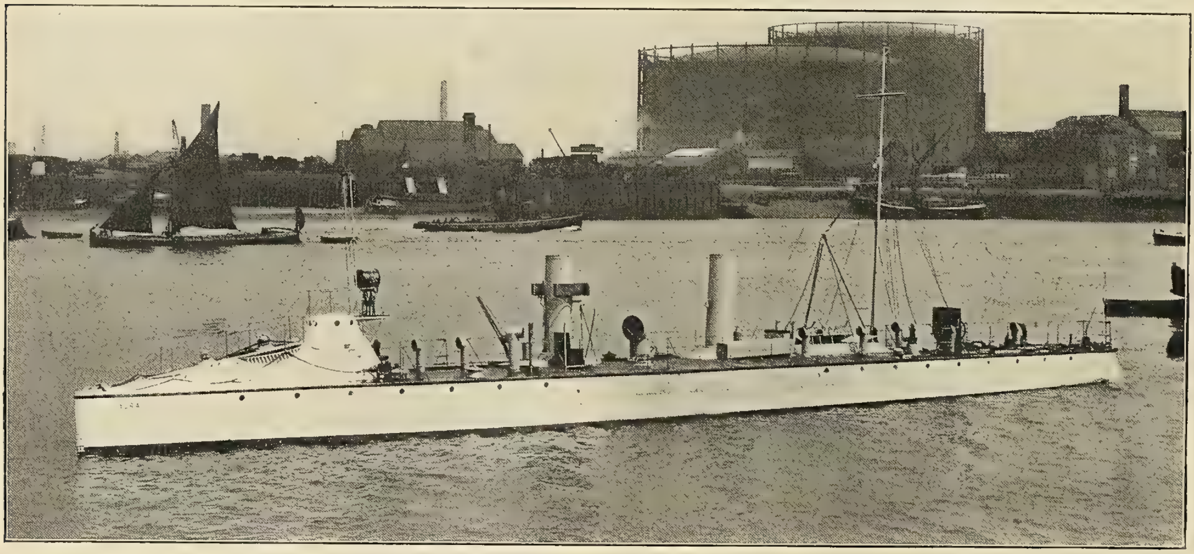
Station Boats.—Turning next to boats of limited endurance, which should be classified as station boats, they can be tactically classified under two heads. (*a*) Sea-going, capable of continuously operating for two or three days at a moderate distance from the base. To this class belong the *Cushing, Ericsson, Morris,* and even the *Winslow.* They are capable of selecting any point on the coast as a base, and can be rapidly mobilized at such point if scattered along our entire coast line of a thousand miles.

(*b*) Station boats whose operations are practically limited to a single night's attack, designed as a part of the coast defense system, operating through the inland waterways from Lake Erie and Buzzards Bay to Fernandina, Fla. Boats of this class are the *Talbot* and the *McKenzie*, the *Cushing* being almost too large for such work. The number of these boats required should be sufficient for the defense of Massachusetts Bay, Narragansett Bay, New York Bay, Delaware Bay, Charleston, Galveston, San Francisco Bay, and Puget Sound. A pair of these boats at each of these points would give a certain feeling of protection to the people, and liberate more valuable and powerful vessels for offensive operations. With the ten monitors now complete or building, distributed at these same points, the Secretary of the Navy would be able to give a satisfactory answer to the clamor for local protection. In the case of imminent danger at any point on the coast, this force could be concentrated to resist such attack, though this movement could not be rapidly effected. We have already the ten monitors which are especially fitted for this rôle; and the cost of sixteen more *Talbots* would be about one-fourth the price of one battleship.

The old Cunarders *Cephalonia* and *Pavonia*, on the Boston-Liverpool route, have been sold out of the service, the former to a Russian and the latter to an Italian ship owner.

Dutch Torpedo Boat Hydra.

In the engraving there is shown a view of the torpedo boat *Hydra* recently completed by Messrs. Yarrow & Co. for the Dutch Government. The *Hydra* is one of two similar boats, the other being the *Scylla.* They are intended to strengthen the naval power of the Dutch authorities in their East Indian colonies. The boats are 130 ft. long, 13 ft. 6 in. beam, and have a displacement of about 90 tons. The contract speed is 23 knots. The machinery consists of a set of triple expansion engines designed to indicate 1,200 horse power. The special feature of these engines, and in which they differ from those of other torpedo boats, is the system of forced lubrication which has been adopted, the working parts of the engine being completely enclosed. This plan has been introduced with great success in many types of land engines, and is becoming a feature of modern high speed engines in small sizes. The great advantage of forced lubrication is that all anxiety on the part of the engineering staff is set at rest as regards this the most important point in the proper working of such fast running machinery. The auxiliaries include a centrifugal circulating pump with its engine for supplying the condenser with water, an evaporator and distilling plant in duplicate; steam steering engine and air compressor; dynamo for electric lighting; an overhead fan and fan engine in the stokehold between the two boilers for forced draft; also a Worthington pumping engine in the stokehold for feeding the boilers when the main engines are not working. The bunkers hold about 18 tons of coal. The armament consists of three 18-in. swivel torpedo tubes, and two 6-pounder quick firing guns.



YARROW BUILT DUTCH TORPEDO BOAT HYDRA, 90 TONS DISPLACEMENT, SPEED 23 KNOTS.

The official trial of the *Hydra* took place on May 25. A mean speed of 24.37 knots was made for the three hours with 160 lb. of steam, and a trifle over 400 revolutions per minute, the load carried being 17 1-2 tons.

The official trial of the *Scylla* took place on June 26, with practically the same results.

BRITISH CENTRAL BATTERY IRONCLAD BELLEISLE BEFORE THE GUNNERY EXPERIMENTS.—SEE PAGE 422.

BRITISH IRONCLAD BELLEISLE AFTER BEING SHELLED BY H. M. S. MAJESTIC FOR NINE MINUTES.

Both these vessels have since had a full speed trial to show their capabilities when burning astatki, by means of Holden's spraying apparatus with which the vessels are fitted. It has been shown by these trials that there is no difficulty in burning this oil, and as it is plentiful in the Dutch East Indies there is no doubt it will be found an important adjunct to coal.

H. M. S. Belleisle Gunnery Experiments.

In a previous issue we described the results of the naval gunnery experiments carried out by the British Navy in which the first class battleship *Majestic* fired all her batteries at the old war vessel *Belleisle* for several minutes, and converted the upper works of the latter into a scrap pile. We now present original photographs (delayed in transmission) showing the *Belleisle* "before and after" the attack. After the attack the *Belleisle* sank on the sand bank over which she had been moored, but this is understood to have been caused by the amount of water pumped into her by the Admiralty tugs to extinguish fires rather than to the effect of shot in the vicinity of the water line. After the *Belleisle* had been pumped dry she was towed to dockyard for repairs. There have been practically completed and further use of the old ship as a target is to be made. On this occasion we are informed greater precautions to insure secrecy as to the result are to be made, and the attack will probably be delivered in some land locked waters on the British coast.

Superimposed Battleship Turrets.

In the preparation of the designs for the five new battleships for our Navy, plans for which will be ready for distribution among prospective bidders on the fifteenth of this month, a compromise was reached by the Naval Board as to the adoption of the superimposed turret. On three of the new battleships tandem turrets will be fitted with 12-in. guns in the lower and 8 in. guns in the upper turrets. On the other two battleships the 12 in. guns and 8 in. guns will be placed in entirely independent turrets in the usual manner. The general appearance of a vessel with tandem turrets is familiar to our readers, but to give a more detailed view we here reproduce a photograph showing the stern of the U. S. S. *Kentucky*. In this the position of the after guns of the main battery with relation to each other, and to the ship as a whole, is easily grasped. Both the *Kearsarge* and *Kentucky*, which are fitted with tandem turrets, can throw a weight of heavy battery fire of 2,700 lbs. astern at each discharge.

New Ore Dock.—What is claimed to be the largest iron ore shipping dock ever built and the largest piece of timber construction in the world has just been completed at the head of Lake Superior for the Eastern Minnesota Railway Co. The deck of the new structure which has to stand the strain of trains carrying 1,200 tons and upwards rises 73.1 ft. above water, the hinge of the ore spout being 40 ft. above water. The dock is 1,500 ft. long, 65 ft. wide and contains 250 ore pockets, each estimated to contain 260 gross tons of ore. The capacity of the dock is 65,000 tons, and all this may be loaded into ships in thirty-six hours.

CHANGES IN VESSEL CONSTRUCTION IN FORTY YEARS OF LLOYD'S REGISTER.*

BY B. MARTELL.

In this paper I propose to give a brief summary of the changes and developments in the construction of ships for the Mercantile Marine during the last forty years.

At the commencement of this period wood was still the principal material employed for shipbuilding, and although iron had been introduced for general ship-building purposes some twenty years earlier, the record of new tonnage added to the British Register in 1860 shows only about 30 per cent. to have been built of iron.

On the Wear, with which district I was early associated, 112 vessels were built in 1860, nearly all of wood, the average tonnage being 359 tons. Some wood vessels of considerable size had been built there, amongst which may be mentioned the *Duncan Dunbar*, of 1,374 tons, and 229 ft. in length, but such vessels were comparatively few. In the larger wood vessels, it had become the practice to fit iron diagonal plates outside the frames, but the practical difficulties of producing a sufficiently strong structure with ships built of wood, prevented that increase of size which has been rendered possible by the introduction of iron and steel.

It is well known that when iron was first introduced, there existed a great deal of doubt as to its suitability for shipbuilding purposes. The stranding of the iron steamer *Great Britain*, the largest vessel of her time, in Dundrum Bay, on the coast of Ireland, in September, 1846, where she was exposed to storms during several months of the winter, and was afterwards found to have sustained but little injury, tended, however, to establish confidence in iron. After visiting this vessel, and witnessing the great endurance of iron compared with wood ships, Sir James (then Mr.) Laing resolved to commence building iron ships, and it is to his initiative that the extension of iron shipbuilding on the Wear is largely due. In the year 1853 he launched his first iron ship, the *Amity*, and in 1866 discontinued the building of wood vessels.

The general adoption of iron for shipbuilding on the Wear dates from about the year 1863, and by 1880 it had, in that district, entirely taken the place of wood. On the Clyde, Mersey, and Tyne, iron shipbuilding was adopted at an even earlier date. So far back as 1855 iron had largely taken the place of wood for shipbuilding on the Clyde.

The first Rules for the construction of iron ships were published by Lloyd's Register in 1855, and provided for the classification of iron vessels for a term of years in the same manner as wooden ships. In those Rules the scantlings of the framing and plating were given for vessels of from 100 to 3,000 tons gross register, and the frame spacing was required to be 16 in. for vessels of the 12 years' grade, and 18 in. for those of the 9 and 6 years' grade.

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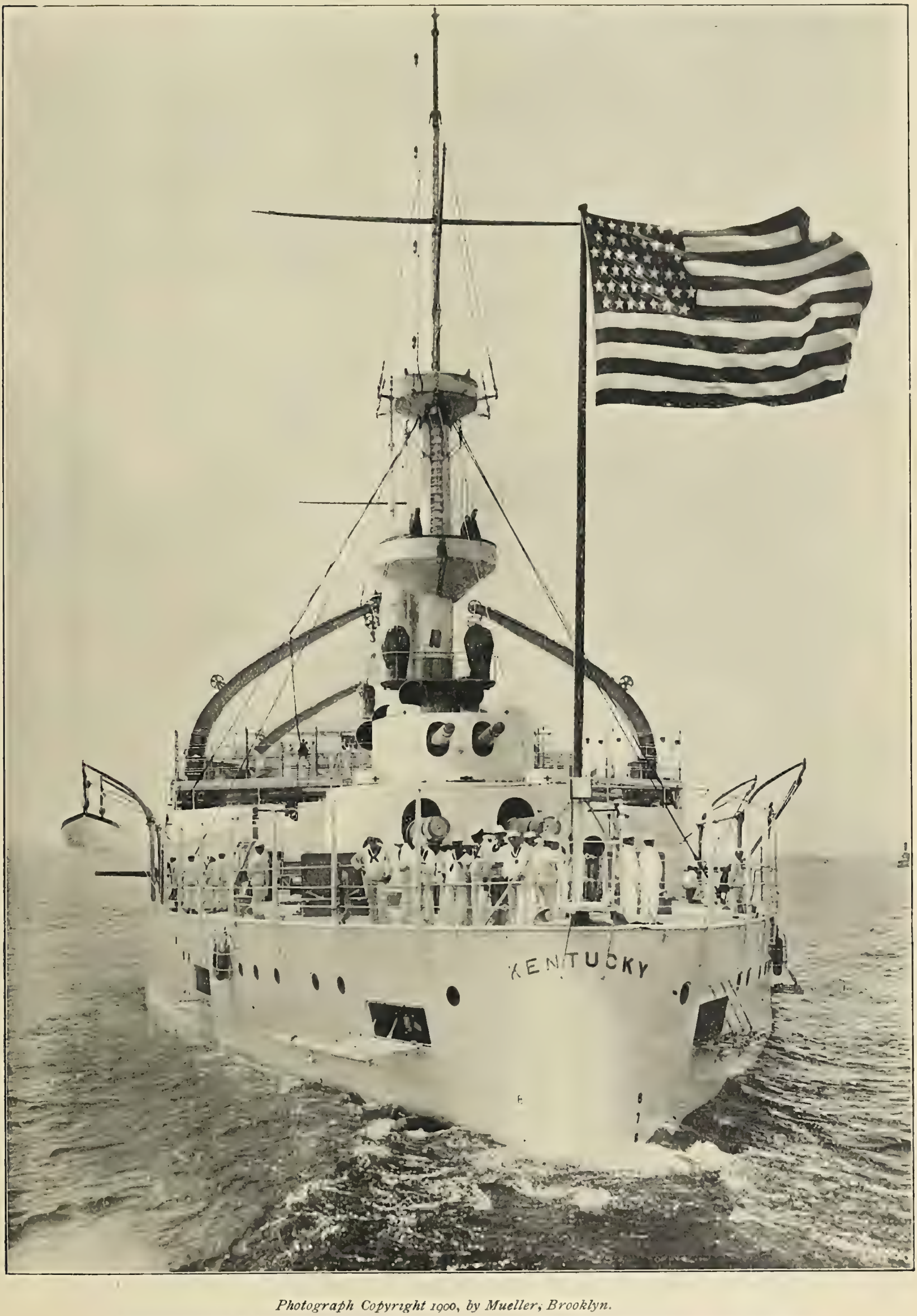
*Read before the Institution of Naval Architects, London.



Photograph Copyright 1900, by Mueller, Brooklyn.

STERN VIEW OF U. S. BATTLESHIP KENTUCKY, SHOWING SUPERIMPOSED TURRETS —SEE PAGE 422.

These Rules are interesting as showing, in the transition from wood to iron, how the ideas and practice relating to wood shipbuilding found expression in the close spacing of frames and distribution of material adopted in the early iron vessels.

In 1863 the Rules of Lloyd's Register for the building of iron ships were revised as the result of growing experience, and new symbols of classification, $\frac{A}{A}$, $\frac{A}{B}$ and $\frac{A}{C}$, were introduced. The first two denoted those vessels which had been built in accordance with, or equal to, the Rule requirements, and the class $\frac{A}{C}$ denoted those vessels which, although not built in accordance with the Rules, were considered entitled to that class.

In those rules the scantlings were given for vessels of from 100 tons to 3,500 tons, and the frame spacing was increased to 21 in., but in vessels having double frames for half length amidships, the frame spacing could be extended to 23 in. for vessels under 1,000 tons, and to 24 in. for vessels of 1,000 tons and upwards.

The difficulty of preventing the fouling of the bottoms of iron ships due to corrosion or marine growths, and the consequent loss of speed, led to various attempts being made to sheath the bottoms of iron ships and cover the wood sheathing with copper, yellow metal, or zinc sheets. The result was the introduction of the system of construction known as "Composite," in which the framing was of iron, with wood planking wrought on the iron frames, and sheathed with copper or yellow metal.

The earliest vessel of this construction was the *Tubal Cain*, of 787 tons, built at Liverpool in 1851. It may be interesting to notice here the construction of that vessel. The iron frames were spaced 18 inches apart, and the outside plank was fastened to the frames with nut and screw bolts, the heads being sunk into the planks and the holes filled with composition. The planks were also bolted edgeways from keel to gunwale. The planking was then sheathed with 1 1-2 in. yellow pine over felt. This wood sheathing was again covered with felt and then copper sheets.

Another of these vessels was the *Gossamer*, of 735 tons, built at Glasgow in 1864, and which had worked outside the frames, an iron sheerstrake and a strake of plating below the hold beam stringer plate, with diagonal plates along the sides above this strake. This ship was wrecked off Prawle Point, and the upper portion was found to have parted from the lower, at about the line of the hold beams, and to have been removed to some distance from the lower portion. After this experience, the diagonal plates were required to be extended from the sheerstrake to the bilge in vessels of composite construction.

In 1864, the *Dilpussund*, of 624 tons, and in 1865, the *Dilbhur*, of 1,308 tons were built in London by C. Lungley. The method of construction was known as Lungley's Patent. Two thicknesses of outside planking were fitted, having iron diagonal plates worked between. The inner thickness was fastened to the iron frames with galvanized iron bolts; iron diagonal plates were then fitted outside the inner planking; the outer thickness of planking was secured to the inner by yellow metal bolts, and the outer thickness then sheathed with yellow metal.

The early composite ships were classed as experimental, and subject to biennial survey, in order that the condition of the fastenings might be examined, and the effects of the galvanic action set up by the iron framing and yellow metal sheathing ascertained from time to time.

In 1867 Lloyd's Register issued suggested Rules for the Construction of Composite Ships. These Rules required iron sheerstrakes and bilge plates to be fitted, and diagonal plates outside the frames, and one thickness of planking, with a uniform frame spacing of 18 in. for all sizes.

The *Sir Lancelot*, 886 tons, built at Greenock in 1865, and the *Thermopylæ*, 990 tons, built at Aberdeen in 1868, which were amongst the most famous of the China tea clippers, were constructed in this manner.

With the opening of the Suez Canal, and the general introduction of steam, the demand for these composite ships ceased, and, except for yachts the composite system of construction for merchant vessels is a thing of the past.

In 1870 the Rules of Lloyd's Register were entirely revised, and instead of the scantlings being regulated by the tonnage of the vessels, they were so arranged as to be regulated by numerals obtained from the principal dimensions. With these Rules new symbols of classification, 100A, 90A and 80A, were introduced. This system remains in use to the present time, and has been found by experience to work satisfactorily.

So far back as 1862, applications were made for vessels to be classed which were to be built with puddled steel, but in the absence of experience regarding the durability of steel, the Committee of Lloyd's Register felt it was not in their power to sanction the proposal.

In 1864, however, a steam yacht of 2,400 tons was built for the Viceroy of Egypt under the survey of Lloyd's Register Surveyors, and constructed partly of steel. A reduction of about one-fourth was allowed in the steel scantlings from those required for an iron ship of the same size.

In 1866 proposals to build a vessel of 1,552 tons with Barrow hematite steel, with about two-thirds the sectional area of scantlings required for iron, were approved on certain conditions for classification, with the notation "Experimental." In the year following, consequent upon a report upon the steel manufactured at Barrow-in-Furness by the Bessemer process, Lloyd's Register Committee decided to class ships built, under special survey, of steel of approved quality, with the notation "Experimental." A reduction in scantlings was allowed not exceeding 25 per cent. of the thicknesses prescribed for iron ships, and the steel was required to have a tensile strength of not less than 30 tons per sq. in.

After this, the question of the suitability of steel for shipbuilding remained in abeyance for several years.

In April, 1876, James Riley, then manager, of the

Siemens Steel Works at Landore, read a paper before this institution on the production of mild steel, setting forth the results of experiments that had been made with steel manufactured by the Siemens-Martin or open hearth process, and showing the qualities of this material as to ductility and tensile strength.

These results were placed before the Committee of Lloyd's Register, and in 1877, plans from John Elder & Co. were approved for the construction of two paddle steamers to be built of this material for the English Channel service, with a reduction of about 20 per cent. in the scantlings which had been adopted for iron vessels.

In the same year, in consequence of a report, which may be found in the volume of Transactions of this Institution for 1877, it was decided to admit steel with scantlings 20 per cent. lighter than prescribed for iron, in vessels building for classification, subject to the material having a tensile strength of from 26 to 30 tons per sq. in., and an elongation of 20 per cent. on a length of 8 in. These limits of tensile strength have since been raised to 28 to 32 tons.

In the paper which I had the honor to read before this Institution in April, 1886, a brief review was given of the progress of mild steel for shipbuilding purposes. It was shown that while in 1878 seven steel vessels, of 4,470 tons, were classed in Lloyd's Register, and 435 iron vessels, of 517,692 tons, the record for the year 1885 showed 118 steel vessels, of 165,437 tons, as compared with 260 iron vessels, of 290,429 tons. As wood was superseded by iron as a material for shipbuilding, so in its turn iron has given place to steel.

Of the total output of the United Kingdom during the past year, 98.8 per cent. of the tonnage was built of steel, and 1.1 per cent. of iron. The iron tonnage was principally made up of trawlers, and comprised no vessel of more than 303 tons.

The following Tables A and B show the relative changes in the number and tonnage of British steamers and sailing vessels of wood, composite, iron, and steel respectively during recent years.

Soon after the introduction of mild steel for shipbuilding purposes, attention was given to the making of heavy steel castings to take the place of iron forgings for stern frames, rudders, propeller brackets, stems, quadrant tillers, etc. These castings are required to be subjected to certain tests, and at the present time are often adopted in place of iron forgings.

It may be here remarked that, notwithstanding the early doubts as to the durability of steel, experience has shown that where proper care is taken to thoroughly clean and paint the surfaces, the deterioration is not appreciably greater than that of iron. In some parts, however, such as thin deck plating, and plating of inner bottom and floors under boilers, steel appears to be more liable to deteriorate, and in consequence of this, iron is often used for these parts, in vessels otherwise constructed of steel.

Having thus outlined the change from wood to iron, and from iron to steel, I will now refer to the great increase in the size of vessels which has taken place in the period under review.

In 1860 the average size of iron steamers built and registered in the United Kingdom was 340 tons; in 1870 it was 580 tons; in 1880 for iron and steel steamers it had become 1,250 tons; in 1890 it had increased to 1,580 tons; and in 1899 it was 1,940 tons.

As regards iron and steel sailing vessels, the average sizes show first an increase and then a great diminution.

In 1860 the average size was 425 tons, in 1870 it was 775 tons, in 1880 it had become 970 tons, in 1890 it had increased to 1,570 tons, and in 1899 it had fallen to 190 tons.

TABLE A.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF BRITISH STEAMERS OF 100 TONS GROSS AND UPWARDS, AS RECORDED IN LLOYD'S REGISTER BOOK.

Year.	Wood.		Composite.		Iron.		Steel.		Total.	
	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).
1886	139	26,051	1	179	4,511	5,455,935	369	679,942	5,020	6,162,117
1889	115	20,059	4	1,750	4,092	5,108,561	921	1,759,806	5,132	6,890,176
1894	114	18,772	6	2,168	3,679	4,140,245	2,523	5,146,598	6,322	9,307,783
1899	115	19,474	7	2,491	2,911	2,633,093	3,887	8,431,183	6,920	11,086,241

TABLE B.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF BRITISH SAILING VESSELS OF 100 TONS NET AND UPWARDS, AS RECORDED IN LLOYD'S REGISTER BOOK.

Year.	Wood.		Composite.		Iron.		Steel.		Total.	
	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).	No.	Tons (Net).
1886	3,328	946,937	119	90,600	1,607	2,132,037	60	79,233	5,114	3,248,807
1889	2,062	552,762	81	58,910	1,505	1,731,100	150	192,235	3,798	2,535,007
1894	1,214	262,652	35	23,312	1,204	1,390,071	486	823,192	2,939	2,499,227
1899	798	147,798	13	5,965	749	902,349	493	784,571	2,053	1,840,683

These averages are, of course, considerably affected by the inclusion of a large number of small vessels. A better idea of the growth will be obtained from the following figures, published in Lloyd's Register Statistical Tables for 1899, showing the average size of vessels classed during the last ten years, and excluding all under 200 tons, in order to avoid the diminution caused by yachts, trawlers, etc.

TABLE C.

COMPARATIVE AVERAGE TONNAGE FROM 1890 TO 1899.

	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.	1891.	1890.
Steam	2,807	2,634	2,452	2,555	2,647	2,219	2,356	2,212	2,100	1,971
Sail	1,612	1,441	1,741	1,826	1,607	1,816	1,684	1,889	1,696	1,783

The following table shows the number, tonnage and description of all vessels of 100 tons and upwards, built in the United Kingdom and still in existence, as recorded in Lloyd's Register Book for 1899.

TABLE D.

TABLE SHOWING NUMBER, TONNAGE, AND DESCRIPTION OF ALL VESSELS OF 100 TONS AND UPWARDS, BUILT IN THE UNITED KINGDOM AND STILL IN EXISTENCE, AS RECORDED IN LLOYD'S REGISTER BOOK FOR THE YEAR 1899.

STEAMERS.

Material.	Under 200 Tons.	200 to 399 Tons.	400 to 599 Tons.	600 to 799 Tons.	800 to 999 Tons.	1,000 to 1,499 Tons.	1,500 to 1,999 Tons.	2,000 to 2,999 Tons.	3,000 to 3,999 Tons.	4,000 to 4,999 Tons.	5,000 to 6,999 Tons.	7,000 to 9,999 Tons.	10,000 Tons and Above.	Total.
Wood	127	13	14	2	...	1	...	...	...	...	...	...	...	157
Composite	7	6	5	3	3	...	...	...	...	...	...	...	...	24
Iron	1,243	600	355	389	348	790	649	445	135	42	13	2	...	5,011
Steel	671	465	323	237	214	496	514	1,360	816	283	233	51	15	5,678
Total.........	2,048	1,084	697	631	565	1,287	1,163	1,805	951	325	246	53	15	10,870

SAILING VESSELS.

Material.	Under 200 Tons.	200 to 399 Tons.	400 to 599 Tons.	600 to 799 Tons.	800 to 999 Tons.	1,000 to 1,499 Tons.	1,500 to 1,999 Tons.	2,000 to 2,999 Tons.	3,000 to 3,999 Tons.	Total.
Wood	619	280	75	25	13	10	...	...	...	1,022
Composite	4	4	18	10	17	8	...	...	...	61
Iron	54	81	126	172	156	417	226	65	3	1,300
Steel	23	42	27	27	22	134	203	170	4	652
Total..................	700	407	246	234	208	569	429	235	7	3,035

I have also appended to this paper a table (see Table F) showing the number, tonnage and description of vessels built and registered in the United Kingdom for the years 1860 and 1870, and for each year since 1880, in order to illustrate the great increase which has taken place in the Mercantile Marine of this country, and a diagram showing the variation in the tonnage of iron and steel steam and sailing vessels during the past twenty years.

The size of vessels launched during 1899, and also those under construction in the United Kingdom at the end of 1899, arranged according to gross tonnage, is shown in Table E on page 427.

The largest steamers which have been launched in the United Kingdom during the past year are the following:

	Tons Gross.		Tons Gross.
Oceanic...........	17,274	Saxon.......... ..	12,970
Ivernia	13,900	Saxonia..........	12,750
Minneapolis... .	13,750	Persic.............	11,973

Germany has launched the *Patricia*, of 13,293 tons, and the *Grosser Kurfurst*, of 12,500 tons, besides six other steamers of 10,000 tons and over.

The figures I have given show very clearly the change which has taken place in the relative number of steam and sailing vessels.

In 1889, 10 per cent of the output was composed of sailing tonnage. For the four following years (1890 to 1893), the proportion rose to 19 per cent. Since that period the construction of sailing vessels has rapidly declined, until in 1899 sailing tonnage formed less than 0.14 per cent of the output.

In France, however, the construction of large sailing vessels, almost abandoned elsewhere, has continued to flourish under the influence of the bounties granted by the state. Twenty-four such vessels, of 2,000 tons and upwards, were launched during 1899. The largest of these, and likewise the largest seagoing sailing vessels built in the world during the past year, are the *Ville de Mulhouse* and the *Ville du Havre*, each of 3,214 tons.

The progress and change as regards types of vessels have been no less remarkable than the development in size and material of construction.

In July, 1891, I had the honor to read before this

Institution a paper dealing with the alterations in the types and proportions of mercantile vessels. In that paper it was shown how various types had been brought into existence as the result of experience, or to meet the exigencies of trade.

I need not now repeat the descriptions given therein of the types which had successively been introduced up to that period; but in continuation of that paper it may be remarked that, while "well-deck" steamers at that time formed so large a percentage of the number of ordinary cargo steamers, comparatively few are now being built, and these are principally intended for the coal trade, or are small vessels for the coasting trade.

TABLE E.

SIZE OF MERCHANT AND OTHER VESSELS (NOT WARSHIPS) LAUNCHED IN THE UNITED KINGDOM DURING 1899.

Tonnage.	Steam.	Sail.
*Under 50 tons	3	2
*50 to 99 tons	8	2
100 to 199 tons	205	5
200 to 499 tons	94	3
500 to 999 tons	39	..
1,000 to 1,999 tons	76	..
2,000 to 2,999 tons	57	..
3,000 to 3,999 tons	129	..
4,000 to 4,999 tons	39	..
5,000 to 5,999 tons	27	..
6,000 to 6,999 tons	15	..
7,000 to 7,999 tons	9	..
8,000 to 8,999 tons	..	..
9,000 to 9,999 tons	4	..
10,000 tons and above	9	..
Total	714	12

* Vessels of less than 100 tons are not included in these returns, unless they are intended to be classed in Lloyd's Register Book.

SIZE OF VESSELS UNDER CONSTRUCTION (WARSHIPS EXCLUDED) IN THE UNITED KINGDOM AT THE END OF THE YEAR 1899, CLASSIFIED ACCORDING TO GROSS TONNAGE.

Tonnage.	Steam.	Sail.
*Under 50 tons	..	7
*50 to 99 tons	4	2
100 to 199 tons	98	9
200 to 499 tons	83	9
500 to 999 tons	31	1
1,000 to 1,999 tons	53	3
2,000 to 2,999 tons	32	..
3,000 to 3,999 tons	78	..
4,000 to 4,999 tons	45	..
5,000 to 5,999 tons	35	..
6,000 to 6,999 tons	17	..
7,000 to 7,999 tons	7	..
8,000 to 8,999 tons	2	..
9,000 to 9,999 tons	6	..
10,000 tons and above	16	..
Total	507	31

* Vessels of less than 100 tons are not included in Lloyd's Register Shipbuilding Returns, unless they are intended to be classed in the Society's Register Book.

The partial awning-deck steamers, which, at the period referred to, were much in favor with ship owners, have also given place to other types, and but few are now being constructed, while those having a raised fore deck, which formed the subject of discussion on the paper referred to, have entirely gone out of fashion.

The tendency has been to revert to flush-deck vessels, having short poop, bridge-house and forecastle, as in the earlier type of steamer, but of much greater relative breadth to depth.

The deep narrow ships which were so commonly built in the seventies, and to which I drew the attention of this Institution in March, 1880, have long since ceased to be built. The erroneous impression that breadth was an insurmountable deterrent to speed was removed by the experiments by the late Mr. Froude, and, since public attention was directed to the large number of losses of badly proportioned steamers, due to insufficient stability, the relative proportion of breadth to depth has been greatly increased.

In 1879 the average relation of registered depth to breadth in vessels of the three-deck type was .69, in 1890 it had fallen to .62, and in 1899 it had still further fallen to .52.

A type of vessel which has been much in favor for certain trades during the past few years is the large single-deck steamer, having a tier of middle or lower deck beams, but no deck laid thereon. There is also a tendency to lengthen the bridge-house in steamers, and in some cases it has been extended over more than half the vessel's length amidships.

Another type of recent development is generally known as the "shelter-deck" steamer, having a continuous superstructure all fore and aft, with one or more "tonnage openings" in the deck. These vessels are constructed principally for the cattle trade, the space between the upper and shelter decks being fitted for that purpose. Some of the larger vessels of this type have a bridge-house of considerable length, built above the shelter deck for cabin accommodation.

The turret-deck steamers, introduced by Doxford & Sons, and the trunk-deck steamers introduced by Ropner & Sons, are so well known to the members of the Institution that I need only mention them as instances of new types created within the last decade.

The subject of water ballast is now occupying a great deal of attention, in consequence of the great increase in the breadth of ships, their comparatively light draught, and the fact that those vessels employed in the American trade mostly proceed to that country in ballast.

In the paper which I read before the members of this Institution in August, 1877, I described the early history of the subject, and the various systems of construction of double bottoms for carrying water ballast. At the present time very few steamers are built without a double bottom for water ballast. Either the cellular or McIntyre system of construction is adopted. Deep midship tanks, in addition to fore and after peak tanks, are now largely fitted, particularly in cargo steamers intended for the Atlantic trade.

One notable step in this direction is the construction of side tanks for a considerable portion of the length. The first of this kind was the *Mancunia*, built by Gray & Co., at West Hartlepool, in 1898, in which the side tanks have a capacity of upwards of 700 tons of water ballast, in addition to the ordinary cellular double bottom.

As regards changes in methods of construction, there may be mentioned the adoption of web frames in lieu of hold beams or lower deck beams. Some

vessels had been so built in the early seventies, but it was not until about 1886 that the system became general, and in 1888 Lloyd's Register issued definite rules for the same, as the result of the experience gained up to that time. Not long after, deep framing, or, as it is sometimes termed, girder framing, came into use. It has since been largely adopted in place of web frames or hold beams, and rules for this system of framing were published by Lloyd's Register in 1895.

A few remarks may be made regarding the progress in the construction of vessels for carrying oil in bulk, a subject on which I read a paper before the members of this Institution at Liverpool, in 1886. At that time there were only about ten steamers specially adapted and engaged carrying oil in bulk on oversea voyages. The current issue of Lloyd's Register shows a list of 174 steamers and 15 sailing vessels carrying petroleum in bulk. Great improvements have been made in the construction of these vessels as the result of experience, and, as with other types of steamers, there has been a great increase in size.

Instead of vessels of about 1,500 tons as first employed in this trade, for oversea voyages the last additions to the fleet of steamers carrying oil in bulk are upwards of 6,000 tons gross register, and over 400 ft. in length.

The progress of marine engineering during the last forty years has been not less marked than that of shipbuilding. In fact, engineering and shipbuilding are so closely allied that everything that influences the one must have a marked effect upon the other. The enormous increase in the sizes of vessels to which I have alluded has only been rendered possible by the advances made in engineering practice, enabling immense power to be placed on board such vessel, with, at the same time, reasonable fuel expenditure. Forty years ago the engines in use were simple cylinders working with low boiler pressure.

In 1872 F. J. Bramwell (now Sir F. J. Bramwell) read a paper before the Institution of Mechanical Engineers at Liverpool on "The Progress Effected in Economy of Fuel in Steam Navigation Considered in Relation to the Compound Engine and High-pressure Steam." The paper was most exhaustive, and should be referred to now as a standard of what was then considered to be excellent practice. He showed that the coal consumption had been reduced from over 3 lb. of coal per indicated horse power per hour to little over 2 lb. The boiler pressures were then 45 lb. to 65 lb. per sq. in., and the average piston speed 376 ft. per min.

In 1881, F. C. Marshall, one of our distinguished marine engineers, and a Member of Council of this Institution, contributed another paper to the Institution of Mechanical Engineers at Newcastle, and he showed that at that time further progress had been made. The use of steel for boilers had enabled pressures of 90 and 100 lb. per sq. in. to be carried, and the higher pressures and improvements in the engines had reduced the coal consumption to 1.8 lb. per indicated horse power per hour. Piston speeds had increased to an average of 467 ft. per minute.

In 1887 the same gentleman read a paper before this Institution on the same subject, and showed that at that time 150 lb. pressure had become common, and that not only had pressures advanced, but the power of the engines had also been enormously increased, the *Umbria* and *Etruria* being instanced as indicating over 14,000 I. H. P. at sea, with a piston speed of 900 ft. per minute. At the same time the consumption of fuel had been reduced to 1.5 lb. per indicated horse power per hour.

At the present time still further advances have been made, 200 lb. per sq. in. is an everyday pressure with some of our largest steamers, and a few are working with still higher pressures—as high as 260 lb. having been reached with ordinary boilers—and the tendency is for further advancement to be made. A corresponding economy of fuel has resulted from the increased pressure, and, if the ideal 1 lb. of coal per indicated horse power per hour has not been actually reached,[1] some of our marine engineers are sanguine that this marvelous result will shortly be achieved. The powers of the engines have also advanced, culminating at present in the *Oceanic*.[2]

In conclusion, I will briefly refer to the load line question, which has occupied so prominent a position during the period under review.

The first step which led up to the present system of supervising the loading of ships was taken in 1869, when a bill was introduced into Parliament containing a clause requiring the draught of water at which vessels leave port to be recorded.

The bill failed to pass, but in 1870 the Merchant Shipping Code Bill was introduced, containing the same provision, and also requiring a scale showing the draught of water to be marked on the stem and stern post of every British ship. These requirements passed into law in 1871, and the same Act also empowered the Board of Trade to appoint persons to record the draught of water of all seagoing ships upon leaving port.

In March, 1873, the Government appointed a Royal Commission on Unseaworthy Ships, and one of the questions considered was that of the load line.

In their final report, issued in 1874, the Commission arrived at the conclusion that a settlement of a load line should be mainly guided by the consideration of reserve buoyancy; but they held it to be impossible to prescribe any universal rule for the safe loading of merchant ships, and were of opinion that an Act of Parliament enforcing any scale of freeboard would be mischievous.

In March, 1874, I read before this Institution a paper on this subject, and with the paper included tables of freeboard based upon the principle of reserve buoyancy.

These tables had been prepared from data collected from all the principal ports of the United Kingdom, relating to the loading of the various types of vessels then in existence.

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1 This result has been achieved in the case of the S.S. *Kensington* and, we believe, in the case of the S.S. *Inchmona* also.—Ed. M. E.

2 The author appears to be under a misapprehension here, as the *Oceanic* has developed less horse power than other vessels in the Atlantic trade which preceded her, and has about 7,000 I H.P. less than the *Deutschland*.—Ed. M. E.

It was then proposed for the first time to use a tonnage co-efficient of fineness as an indication of the form, in order to adapt the principle upon which the Tables were based to the many thousands of vessels afloat, without the necessity of calculating the displacement from the drawings, or of placing the vessel in dry dock for the purpose of obtaining the form.

In 1875, a short bill, to remain in force only till October of the following year, was passed, containing provisions requiring all British ships to have the position of their decks marked upon the sides, and every *foreign-going* British ship was also required to have a circular disc marked upon the sides, indicating the maximum draught to which the owner claimed to load.

TABLE SHOWING THE NUMBER, TONNAGE, AND DESCRIPTION OF VESSELS BUILT AND REGISTERED IN THE UNITED KINGDOM.

		Steel.		Iron.		Wood and Composite.		Total.	
		No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).	No.	Tons (Gross).
1860	Steam	—	—	149	51,115	49	2,681	198	53,796
	Sail	—	—	32	13,584	786	144,588	818	158.172
1870	Steam	—	—	382	222,922	51	2,752	433	225,674
	Sail	—	—	63	48,838	478	68,194	541	117,032
1880	Steam	26	36,493	362	447,389	20	1,779	408	485,661
	Sail	4	1,671	39	40,015	273	18,159	316	59,845
1881	Steam	34	68,366	411	590,503	30	1,659	475	660,528
	Sail	3	3,167	50	68,650	259	16,448	312	88,265
1882	Steam	65	115,449	446	672,740	30	1,784	541	789,973
	Sail	8	12,478	83	112,852	246	13,066	337	138,396
1883	Steam	92	141,552	548	742,292	30	1,651	670	885,495
	Sail	11	14,193	72	114,698	229	13,551	312	142,442
1884	Steam	67	108,978	413	456,982	38	2.364	518	568.324
	Sail	9	13,360	93	130,017	277	17,142	379	160,519
1885	Steam	122	154,249	177	148,508	37	2,751	336	305,508
	Sail	27	30,569	144	160,034	266	17,841	437	208,444
1886	Steam	124	160,973	119	82,201	30	1,467	149	244,641
	Sail	31	30,588	55	97,713	226	14,266	281	142,567
1887	Steam	196	326,530	66	40,070	24	1,097	90	367,697
	Sail	29	25,994	27	44,979	170	8,782	197	79,755
1888	Steam	321	571,437	87	31,697	23	2,370	110	605,504
	Sail	33	42,666	13	18,882	177	8,686	190	70.234
1889	Steam	411	783,193	97	46,402	25	1.368	533	830,963
	Sail	47	90,469	11	12,385	157	8,256	215	111,110
1890	Steam	432	817,010	110	40,144	26	1,326	568	858,480
	Sail	59	96,374	6	5,911	142	7,704	207	109,989
1891	Steam	388	730,051	167	31,381	25	1,212	580	762,644
	Sail	93	178,593	3	1,544	156	8,541	252	188,678
1892	Steam	365	660,847	86	18,937	19	1,026	470	680,810
	Sail	128	260,874	6	5,121	151	8,372	285	274,367
1893	Steam	328	622,099	64	12,458	27	1,551	419	636,108
	Sail	66	113,097	4	418	154	7,980	224	121,495
1894	Steam	389	751,668	65	12,400	26	1,183	480	765,251
	Sail	67	83,167	3	207	155	7,570	225	90,944
1895	Steam	379	736,412	66	9,897	35	1,579	480	747,888
	Sail	32	41,313	9	782	150	7,529	191	49,624
1896	Steam	398	750,106	79	11,593	17	591	494	762.290
	Sail	36	37,709	5	792	161	7,519	202	46,020
1897	Steam	366	658,646	63	9,974	33	1,581	462	670,201
	Sail	34	28,481	2	232	183	8,317	219	37,030
1898	Steam	546	996,814	80	13,654	20	765	646	1,011,233
	Sail	40	8,456	6	798	196	8,813	242	18,067
1899	Steam	534	1,152,999	64	12,184	29	1,497	627	1,166,680
	Sail	60	11,757	2	182	165	7,342	227	19,281

These provisions were confirmed by a larger Act passed in 1876, which extended the compulsory marking of disc and deck lines to *all* British ships, except those under 80 tons, engaged exclusively in coasting and those employed in fishing, and pleasure yachts. Prior to the passing of the Act of 1876, a Committee had been appointed by the Board of Trade to consider the possibility of framing rules for regulating freeboard. This Committee comprised representatives of the Board of Trade, Lloyd's Register, and the Liverpool Underwriters' Registry, but the attempt to establish an authorized scale of freeboard failed.

The subject of freeboard, however, continued to occupy a great deal of attention on the part of Lloyd's Register, and the investigations necessary for arriving at a settlement of the question and the collection of all available data were carried on by the Society's officers for several years.

The result was that in August, 1882, the Committee of Lloyd's Register issued the first authoritative Tables of Freeboard, and undertook to assign freeboards on the basis of those tables where the owners made application for the same. During the time these tables were in use, a period of about three years, freeboards were assigned to 944 vessels, and in the case of 775 of this number, the freeboards were voluntarily accepted by the owners and marked upon the vessels' sides.

In December, 1883, the Board of Trade appointed the Load Line Committee, and in 1885, after prolonged labor and investigation, that Committee presented its report. The Load Line Committee's Tables, which agree closely with the tables previously issued by the Committee of Lloyd's Register, were adopted by Lloyd's Committee, in September, 1885.

Between that time and June, 1890, when the Load Line Act was passed, freeboards were assigned by Lloyd's Register, on the application of owners, to 2,850 steam and sailing vessels, and these freeboards were adopted in 2,520 cases.

Since the passing of the Load Line Act, some modifications have been made in the application of the Freeboard Tables to meet the development of new types and methods of construction, and the regulations have been revised on the recommendation of committees appointed by the Board of Trade, and representing the various assigning authorities, in the years 1892, 1894 and 1898.

In the last-named year, the freeboard required for winter North Atlantic voyages was revised, and the tables of freeboard were extended to provide for vessels of much greater size than included in the original tables.

A Five-Thousand-Ton Wooden Schooner.

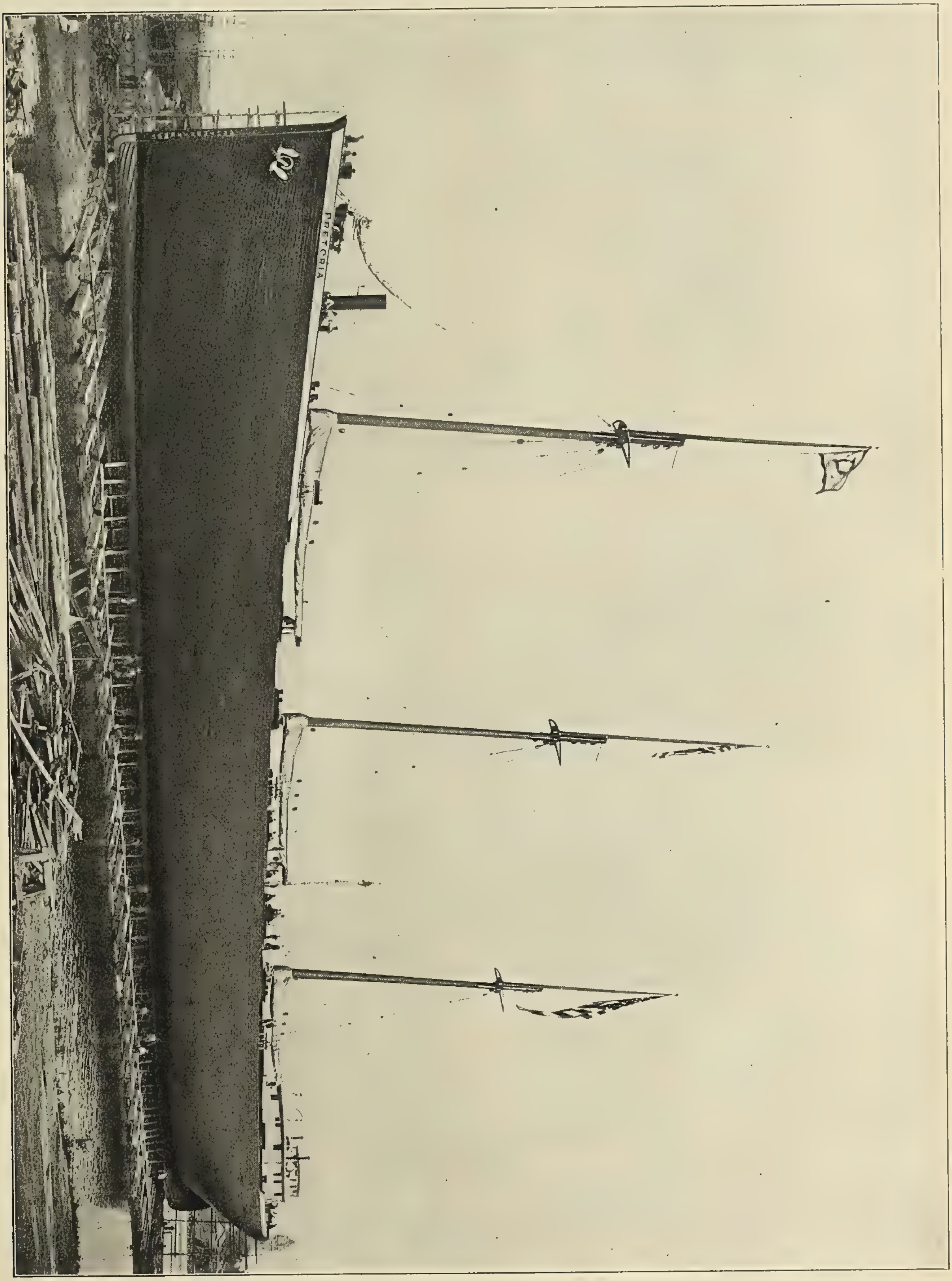
Although steel has superseded wood to a very great extent as a material for the construction of large modern vessels, yet on both the coasts and lakes wood construction is not by any means a lost art. We show in the accompanying reproduction a photograph of what is believed to be the largest wooden sailing vessel ever built. This is the *Pretoria*, built and owned by James Davidson, of Bay City, Mich. The photograph was taken a few minutes before the vessel was launched from his yard. Her dimensions are: Length of keel, 335 ft.; length over all, 350 ft.; beam, 45 1-2 ft.; depth moulded, 27 ft.; depth of hold in shoalest place, 23 ft.; carrying capacity 5,000 gross tons on 18 ft. 6 in. draft; light draft, 6 ft., forward and 6 ft. aft. The *Pretoria* was launched July 26, last.

The *Pretoria* has eleven hatches, and they are all spaced 24 ft. centers. This schooner is built entirely of Michigan white oak, and her frames are moulded 16 in. at the throat, 14 in. at the bilge and 7 in. at the top. The main kelson is 18 in. by 18 in., and alongside of each side of the main kelson are steel kelson plates 18 in. by 1 in. The *Pretoria* also has six strakes of floor kelsons on each side of her main kelson running the entire length, in size 12 in. by 12 in. All of the frames have an extra floor timber running from bilge to bilge. The frames are moulded out of flitch that is 6 in. thick. On the outside of the frames —at the head of the frames—there runs a steel cord that is 14 in. by 7-8 in. There are also steel arches running along the steel cords amidships to the fore foot forward and under the stern aft. In addition to these the *Pretoria* is diagonally strapped with steel. The diagonals are 5 in. by 1-2 in. These diagonals straps are riveted to the cord, to the arch and at all of the crossings, and go under the turn of the bilge about one-third of the way under the bottom. The cords, arches and diagonal straps are all let into the frames flush, and then the ship is planked so that all of the strapping is concealed.

Upper deck beams of the vessel are 8 in. by 8 in., 8 in. by 9 in., and 8 in. by 10 in. The between deck beams are 11 in. by 11 in., and 11 in. by 12 in. Between each hatch there is an iron rod running from side to side, and this is 1 1-2 in. set up in the center by means of a turn buckle.

The *Pretoria* is supplied with stockless anchors and 1 3-4 in. chain. The windlass is located on the upper deck forward. A submerged tube upright boiler 6 ft. in dia. by 8 ft. high, and allowed 160 lb. steam pressure furnishes steam for the steam deck appliances. A large pony pump is located forward for use in case of fire, for filling the boiler, and also for washing off the decks, etc. A syphon is also located forward. A deck hoist to which bilge pumps are attached is located amidships. The deck hoist is for handling the sails, and also for use in warping the vessels at the wharves. The *Pretoria* is steered by means of a Queen City Hydraulic Steerer.

Crew space is located forward under decks. The cabins are located on the upper deck, and all of the cabins are in the hard wood, cabinet finish. The Master's quarters as well as the officers' are located in the cabin aft. The *Pretoria* is now engaged in the general carrying trade on the Lakes, which consists of coal, ore and grain. While she was built to tow as a consort after large steamships, yet she is equipped with masts, and these masts all have sails, and she has a sail area of 1,800 yards. These sails are utilized when the winds are fair, or in the case of storms, should she break away from the towing steamer, she will be able to take care of herself all right until the weather moderates.



FIVE THOUSAND TON WOODEN SCHOONER PRETORIA, READY FOR LAUNCHING AT DAVIDSON SHIPYARD, BAY CITY, MICH.

MARINE ENGINEERING

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STATISTICS are usually dry reading, especially when they show conditions unfavorable to the reader's interests. The reverse is the case, however, in the perusal of the complete official returns of the United States Bureau of Navigation for the fiscal year ended June 30, 1900, which show a most pleasing record of progress in construction. The record of the year shows a total of 393,168 gross tons of merchant shipping, a total which has only twice been exceeded since "before the war," that starting point of the decay of the American merchant marine. Not to multiply details, however, we shall here print the document itself:

> Complete official returns for the fiscal year ended June 30, 1900, show that 1,446 vessels of 393,168 gross tons were built and documented in the United States. Since 1856 this record has been exceeded only twice: in 1864, when 415,740 gross tons were built, and in 1874, when 432,725 gross tons were built.
>
> The construction may be classed according to the following types: Schooners, schooner barges, and sloops 499, of 109,605 gross tons; Great Lake steam vessels 25, of 97,847 gross tons; canal boats and barges 523, of 74,860 gross tons; ocean screw steamships 20, of 60,369 gross tons (of which all but one, the *Maracaibo*, 1,771 gross tons, were built wholly or principally for trades reserved by law to American vessels); river steamers 375, of 44,282 gross tons; square-rigged vessels 4, of 6,205 gross tons.
>
> The steam vessels built—420 of 202,498 gross tons—surpass the record, the nearest approach being 1891, when 488 steam vessels of 185,037 gross tons were built.
>
> The steel vessels built—90 of 196,851 gross tons—exceed the previous record year, 1899, when 91 such vessels of 131,379 gross tons were built. Cleveland, Ohio, ranks easily first as builder of steel vessels, with 9 steamships of 42,119 gross tons, followed by Newport News, 7 steamships of 28,202 gross tons; Chicago, 5 vessels, 24,504 tons; Detroit, 4 steamships, of 15,693 tons. During the past decade the steel steam vessels built in the United States aggregate 465 of 742,830 gross tons, of which 198 of 450,089 gross tons were built on the Great Lakes. For comparison it may be noted that the British Board of Trade reports that 727 steel steam vessels of 1,423,344 gross tons were built in the United Kingdom during 1899. During the ten years 69 steel steam vessels, of 194,080 gross tons, were built at Cleveland, and 110 of 138,593 gross tons at Philadelphia.
>
> The total tonnage built and documented on the Great Lakes during the year, 125 vessels of 130,611 gross tons, is the largest in the history of that region. The total for the Middle Atlantic and Gulf coasts, 605 vessels of 135,473 tons, exceeds any record since 1872. The total for the New England coast, 199 vessels, of 72,179 gross tons, has not been equalled since 1891, while the product of the Pacific Coast, 300 vessels, of 40,396 tons, is surpassed only by the returns of 1898 and 1899. Construction on Mississippi River and tributaries, 217 vessels, 14,509 tons, is 9,000 less than 1899. The foregoing figures do not cover yachts or Government vessels.

The last sentence is noteworthy. It recalls the fact that, while the figures given are indicative of the progress of our merchant marine, they do not represent all the activities in marine construction in our yards.

WITH the steady growth in marine construction which the last couple of years has witnessed, there has come an increased demand for skilled workers, especially those trained for usefulness in the drawing room. Workers in the shop can more readily and suc-

cessfully transfer their attentions from one branch of engineering construction to another than can those to whom is intrusted the task of design. In no branch of engineering is there greater need for specialization, or careful training in a particular field, than in marine construction. In fact, the breadth of this field is such that real success is often achieved only by limitation to some particular form of construction. This is not only so with individual designers, but even with yards. The most famous yards in the world have almost without exception built up a great reputation in one particular class of work. This need for scientifically trained men has caused a recent increase in the number of scientific schools which offer special courses in marine construction. Whether this will maintain the equilibrium between supply and demand, or whether supply will at no distant time overbalance demand, is a question that no one can answer now. The survival of the fittest will always operate to bring success to those that deserve it, but this is a slow process of selection. In the meantime the only danger to be feared is the multiplying of facilities for instruction beyond the possibilities of future profitable employment for the graduates. Such conditions tend to cheapen any profession and lead to the deplorable results which are so often observable in the medical, legal and other learned professions. Since our last reference to these increased facilities, the course in Naval Architecture at the University of Michigan has been strengthened by the addition of Professor Herbert C. Sadler, late of the Glasgow University, Scotland, to the faculty at Ann Arbor. Professor Sadler is widely known in the profession on both sides of the Atlantic, and our readers will recall a more extended reference to his capabilities in our description of the course in the Glasgow University, published in the August issue. The course at the University of Michigan, which commenced Sept. 25, is arranged as a graduate course, and commences at the second semester of the senior year, and extends to the end of the fifth year. At the end of the senior year engineering students may receive the degree of Bachelor of Science, and at the end of the fifth year that of Master of Science. For this year only a special course has been arranged which will end in June next. In the future it is proposed to extend the course in naval architecture and marine engineering over one and one-half years. The work will consist of lectures, drafting, and visits to shipyards, and, we are informed, will in general follow the course given at Glasgow University. At the New York University, where a course in marine construction has recently been established under the direction of Professor Carl C. Thomas, arrangements have been completed for the instruction of engineering students in practical shop work. At present the facilities cover machine shop, carpenter shop, pattern shop and forge. Work is also going forward on the equipment for foundry work. In connection with the drawing room for the students of marine construction, floor space has been provided for a mould loft. We understand that it is the intention of the authorities of two other American universities to establish marine courses in the near future.

WE publish on another page in connection with a description of the new German transatlantic liner *Deutschland* a picture of the launching ceremonies, which tells better than a whole volume of words the attitude of Germany toward her merchant marine. Instead of being simply a pleasant incident in the ephemeral history of a private yard, the launching was made a state event of national importance. The Emperor of Germany, accompanied by Count Von Bülow and a brilliant staff, attended the launch, and when the great hull slid into the River Oder, the entire nation watched the event and rejoiced that another agency for the promotion of German interests had come into being. In the complete history of marine construction, the most remarkable chapter would be, without doubt, that devoted to the tremendously rapid rise of the German shipbuilding and shipowning industries. Only a few years ago every ocean liner of importance flying the German flag was foreign built; now ships of the finest construction carry the message of German skill in construction to every port on the seas. More notable still, the supremacy of the seas in the matter of ocean-going vessels rests with the German builders. It matters not that British brains helped to produce these magnificent vessels; the enterprise which made their construction possible, and the skill which put the designs into practical form, are German undiluted. To the fostering care of the government and the wakeful interest of an up-to-date monarch these results are in large measure due. When such results are possible in a country where government by the few obtains, what could not be accomplished in our own country by the united efforts of the governing powers —the people?

BALANCING OF VERTICAL MARINE ENGINES DISCUSSED IN AN ELEMENTARY MANNER.*

BY J. MACFARLANE GRAY.

ELEMENTARY INTRODUCTION.—(SECOND CHAPTER.)

My next auxiliary note is that if in the circle BNE, Fig. 8, any point D be taken and a chord BE drawn through D, then has BD.DE the same value in whatever direction the chord may be drawn through the same point. Bisect BE in C, draw BJ, CK, DL, EM perpendicular to BE, and at the distance BF = DE and the distance BJ = CE draw FH and JM parallel to BE. From inspection of the figure it is then seen that

$$\begin{aligned} BD.DE &= BD.DH + CD^2 = CE^2 \\ \text{add} \quad & \qquad\qquad AC^2 = AC^2 \\ \text{then} \quad & BD.DH + AD^2 = AE^2 \end{aligned}$$

but AD^2 is constant for the same point D, and AE^2 is also constant, because AE is the radius of the circle; therefore BD.DH must also be a constant product for all lines through the same point D. Therefore if two chords in a circle cut one another, the product of the parts of the one is equal to the product of the parts of the other. This is a property so important to be understood by engineers, I have not hesitated to give you this sufficient demonstration of it, and now I can use this in the reasoning up to balancing.

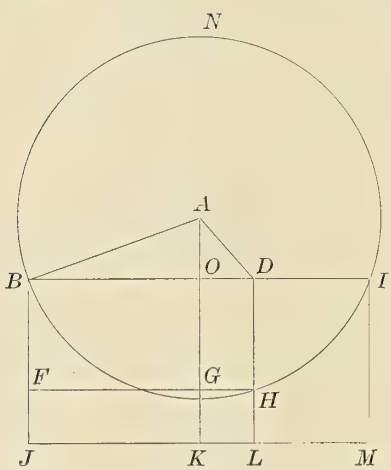


FIG. 8.

We want workable expression for the value of x for any position of the crank pin. In Fig. 9, let the two circles be drawn, one with the connecting rod as radius and the other with the length of the crank as radius. Since AD and EF are two chords in a circle cutting one another in the point C, the product EC.CF = AC.CD or $(2\,nr - x)\,x = (\text{R} \sin a)^2$, for CF $= x$, and AOC $= a$, and AC = R sin a,

$$\text{therefore } x = \frac{(\text{R} \sin a)^2}{2\,n\,\text{R} - x} \ldots\ldots\ldots\ldots (11)$$

As x is always small in comparison with $2n$R it is customary to neglect it in the division, and to write

$$x = \text{R}^2 \sin^2 a \div 2n\text{R} \ldots\ldots\ldots\ldots\ldots (12)$$

therefore h in Fig. 6, the height of the piston above half stroke position, is

$$h = \text{AB} - \text{AC}^2 / 2n\text{R} \ldots\ldots\ldots\ldots\ldots (13)$$

which may be read as

$$h = \text{R} \cos a - \text{R}^2 \sin^2 a / 2n\text{R} \ldots\ldots (14)$$

Here the sloped line stands for "divided by." The rate at which this is changing is the velocity of the piston. We can now write-in these rates of change, for AB it is ω. AC: we have to add to this the rate at

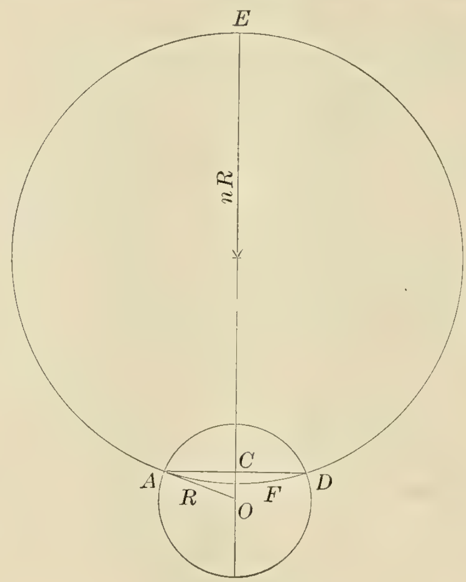


FIG. 9.

which $\text{AC}^2/2n\text{ R}$ is changing. The rate at which the area of a square changes is the product of twice the side of the square by the rate at which the side is changing. In this case, therefore, for AC^2 we have $2\text{AC}\cdot\omega$. AB. Therefore the velocity of the piston downwards is

$$\text{velocity} = \omega.\text{AC} + 2\text{AC}\ \omega.\text{AB} / 2n\text{R} \ldots (15)$$
$$= \omega.\text{AC} + \omega\text{AC}.\text{AB}n\text{R} \ldots\ldots\ldots (16)$$

This is still only velocity, and it is accelerity we want. To get that we have to find out at what rate the last expression is changing. We know how to deal with the first term in it; we had that before, it is $\omega.\omega$ AB. For

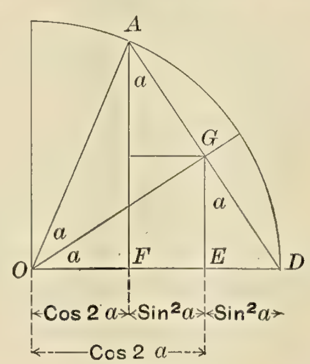


FIG. 10.

the second term, we have to ask ourselves at what rate the area of a rectangle whose sides are AC and AB is changing, knowing the rate at which the lengths of the sides are changing. Evidently this must be the sum of the products of AB by the rate at which AC is changing and of AC by the rate at which AB is changing. As AB is diminishing the latter must be deducted, not add-

*A paper read before the Institute of Marine Engineers, London, England.

ed. Writing these down we have the accelerity of the piston when the pin is in the position A.

$$\text{Accelerity} = \omega\left(\omega AB + \frac{AB.\omega.AB - AC.\omega.AC}{nR}\right) \quad (17)$$

$$\text{or} = \omega^2\left(AB + \frac{AB^2 - AC^2}{nR}\right) \ldots\ldots\ldots\ldots (18)$$

$$\text{or} = R\,\omega^2\left(\cos a + \frac{\cos^2 a - \sin^2 a}{n}\right) \ldots\ldots\ldots (19)$$

As some student new to this kind of reasoning may be puzzled over $\cos^2 a$ for $(\cos a)^2$, I explain that the meaning of $\cos^2 a$ is $(\cos a)^2$, and the form $\cos^2 a$ is adopted for convenience, as it cannot lead to any confusion. It is the same with all other trigonometrical quantities.

To simplify (19), observe that in Fig. 10 it is shown that

$$\cos^2 a - \sin^2 a = \cos 2a \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

Making the radius $OA = 1$ we have $OC = \cos a$,

$$\text{and } OE = \cos a . \cos a = \cos^2 a \ldots\ldots\ldots (21)$$

also $AC = \sin a$, and $FE = \sin a . \sin a$.

$$\sin a \sin a = \sin^2 a = FE \ldots\ldots\ldots\ldots\ldots (22)$$

therefore (20), $\cos^2 a - \sin^2 a = \cos 2a$.

We can therefore now write

$$\text{Accelerity} = R\omega^2\left(\cos a + \frac{\cos 2a}{n}\right) \ldots\ldots\ldots\ldots (23)$$

This consists of two parts; the first is the primary accelerity as with a slot connecting rod, the other is the

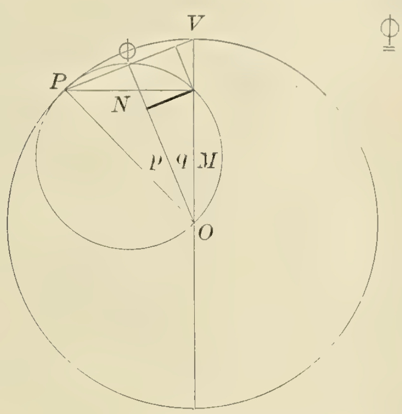


FIG. 11.

secondary accelerity, or what is due to the obliquity of a swinging connecting rod.

What is true for one crank and its weights is also true for any number of cranks on the same shaft. Instead of RW for the product of length of crank by weight for the crank at angle a write the capital letter A, and if there are other cranks with other weights at angles b, c, d, etc., write for these the capital letters B, C, D, etc., and the accelerity force at any instant tending to lift the engines will be equal to the constant $\frac{\omega^2}{g}$ multiplied by $\Sigma A \cos a + \frac{1}{n} \Sigma A \cos 2a \ldots\ldots\ldots\ldots\ldots (24)$

Here Σ stands for the summation of all the quantities similar to that before which it is written, or for $A \cos a + B \cos b + C \cos c$, etc., and similarly the second term is the sum of $\frac{1}{n}$ $(A \cos 2a + B \cos 2b + C \cos 2b$, etc.). The angles a, b, c, etc., are here the angles of the cranks from the vertical for one position of the shaft; that we elected for the initial position, measured as in Fig. 5.

We have seen that an equivalent crank P at angle p can be found as in Fig. 2 for the effect as with a slot connecting rod, and it is evident that another equivalent crank Q at angle q can be found in the same way for the effect of the swinging connection rod, if we set off the cranks at the angles $2a$, $2b$, $2c$, $2d$, and finally divide by n the ratio of the length of the connecting rod to the length of the crank. These will be the primary equivalent crank and the secondary equivalent crank.

On Fig. 11 let P be the primary equivalent crank in the initial position. Its rectangular components are

$$M = P \cos p = \Sigma A \cos a \ldots\ldots\ldots\ldots (25)$$

$$\text{and } N = P \sin p = \Sigma A \sin a \ldots\ldots\ldots\ldots (26)$$

when p=POV.

If a circle be imagined as described upon OP and carried round with OP as the shaft revolves to the right, writing p for the varying angle between P and the vertical the vertical line VO, now ΦO will cut this circle and the intercept or chord will always be P cos p, the quantity to be multiplied by $\frac{\omega^2}{g}$ for the primary vertical force.

From the diagram Fig. 11 it is obvious that

$$P \cos p = M \cos \phi + N \sin \phi \ldots\ldots\ldots (27)$$

if ϕ be angle the shaft has rotated from the original position; that is, $VO\Phi = \Phi$, and $\Phi OP = p$.

This may be written:

$$P \cos p = \cos \Phi\, \Sigma A \cos a + \sin \Phi\, \Sigma A \sin a \;.\,.(28)$$

It is evident that if we treated the second term of 23 in the same we would get:

$$Q \cos 2q = \cos 2\Phi\, \Sigma A \cos 2a + \sin 2\Phi\, \Sigma A \sin a \quad (29)$$

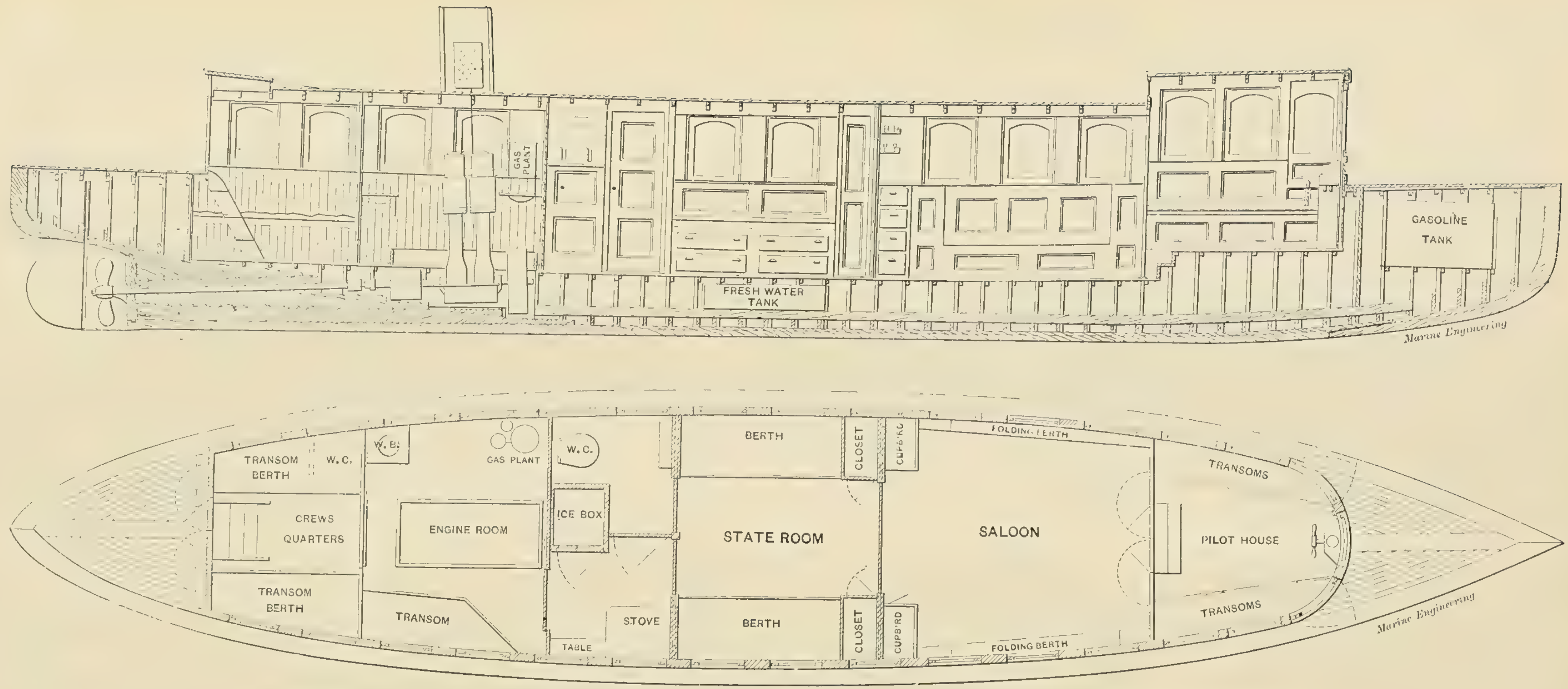
The vertical force lifting the engine is therefore

$$\frac{\omega^2}{g}\left\{\begin{array}{l}\cos \Phi\, \Sigma A \cos a + \sin \Phi\, \Sigma A \sin a + \frac{1}{n} \\ (\cos 2\Phi\, \Sigma A \cos 2a + \sin 2\Phi\, \Sigma A \sin 2a)\end{array}\right\} \quad (30)$$

Gasoline Pleasure Launch Au Revoir

The launch *Au Revoir*, recently constructed by the Greenport Basin & Construction Co. for H. D. Milderberger, forms an interesting example of the application of gasoline motor power to the larger classes of pleasure launch. The chief dimensions of this boat are as follows: Length over all 58 ft., extreme beam 11 ft., draft 3 ft. 1 in. As shown on the accompanying drawing the arrangements provide for a main cabin with saloon and stateroom, while accommodations for the crew are provided forward. The saloon is handsomely paneled in butternut, and is provided with two folding berths so arranged when closed up as to form side panels, while above these a shelf runs the length of the saloon on each side. In order to economize space the doors are fitted to slide on tracks rather than to swing on hinges. The stateroom is finished similarly to the main saloon, and so arranged as to make one large room when both are opened. All mattresses, pillows and cushions are of felt and made by the Ostermoor Co., while pantasote was used in the crew's quarters and engine room.

The motive power is provided by a 16 H.P. Russ motor, which will be found more particularly described on another page of the present issue of MARINE ENGINEERING. As noted on the plans a stack is



PLANS OF THE GASOLINE PLEASURE LAUNCH AU REVOIR, BUILT BY THE GREENPORT BASIN & CONSTRUCTION CO., GREENPORT, L. I.

provided into which the exhaust is led. This also improves the general appearance of the boat. Located just forward of the stack is an air whistle for signaling, etc.

The *Au Revoir* is intended largely for river service, where shoal water prevails, and for this reason it was decided to give the hull proper the full draft, and thus afford better protection to the propeller, rather than use a dropped skag under the wheel with a decreased draft of hull. The lines of the boat have been made as easy and fine as the requirements of the accommodations would permit, and she enters and leaves the water with but little disturbance, even when at full speed. A small boat as a tender is carried on the top of the cabin, the davits for swinging it in and out being fitted on the starboard side.

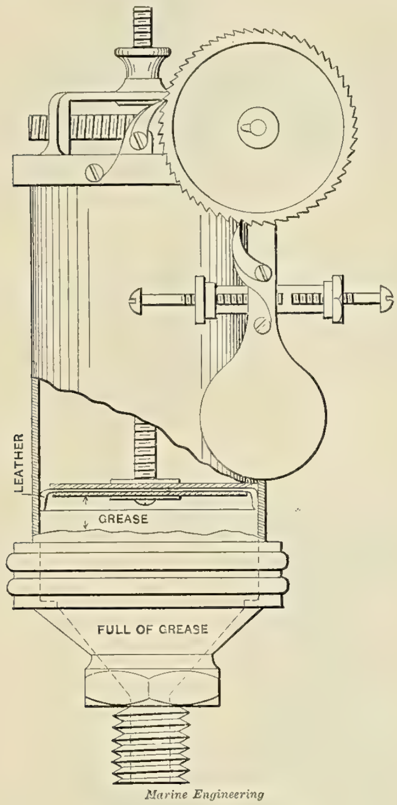
This launch is an example of a class of pleasure boat which is likely to become more common as the practicability of the design and construction become better known—a class of boat large enough to give more accommodation and comfort than can be provided on the usual small size of motor boat, and at the same time having the especial advantages of simplicity of machinery, readiness for instant use, etc., which have made the smaller sizes so popular among the patrons and owners of pleasure craft.

Another interesting feature of this launch is found in the acetylene gas plant for illumination. This provides for the usual interior illumination, and for a searchlight as well. The J. B. Colt Company's apparatus is used, consisting of an improved type of "carbide feed" generator and gas tank with the necessary connections, special burners, etc. The searchlight is 8 1-2 in. dia. and is provided with double reflector and lens, by means of which a brilliant beam of light can be projected upwards of 1,000 feet.

IMPROVED APPARATUS.

Improved Grease Cup.

A novel form of lubricator for use with grease has been brought out by James L. Robertson & Sons, 204 Fulton street, New York, under the name of the Tic-a-toc automatic grease cup. The shank is screwed into the connecting rod end or eccentric strap in the usual way, and the cup is readily detachable for filling

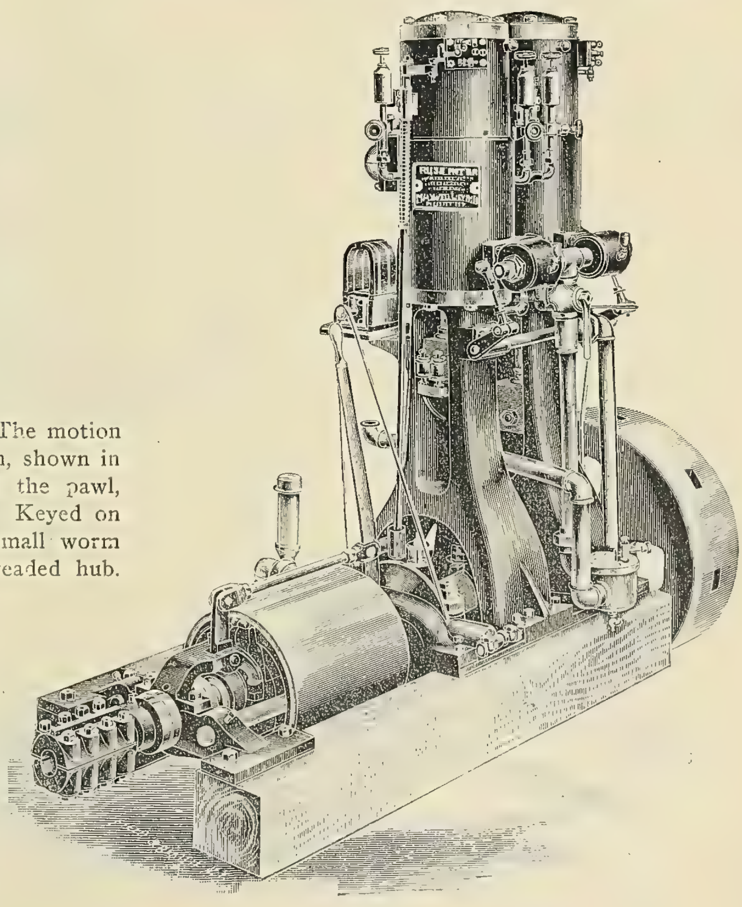


TIC-A-TOC GREASE CUP.

at any time when stopped or under way. The motion of the rod or strap sets the small pendulum, shown in the drawing, swinging, and this operates the pawl, which engages in the ratchet feed wheel. Keyed on to the same spindle as this wheel is a small worm which engages a worm wheel with a threaded hub. Through this hub passes the central screw attached to the plunger inside the cup. To control the swing of the pendulum and the consequent coarseness of feed, two set screws with lock nuts are provided, so that the cup can be adjusted to feed between a wide range of speeds. The feed is positive and automatic, starting immediately as the engine starts, and stopping when the engine has finished turning. The bearings do not have to become warm to start the lubrication. With this form of cup, graphite grease can be used to advantage. It is made in a variety of sizes, containing from 4 oz. to 18 oz. of grease when filled, and is sent on thirty days' trial.

Russ Gasoline Motor.

For marine purposes the Russ motor is intended to use gasoline for the generation of the gas required for its operation. While available for all types of service for which gas engines may be used, special care has been given in the design to the production of a reliable and efficient motor for marine purposes. It is made of the two cycle type, and thus gives a power stroke for each revolution of the engine. It is claimed that in the design of this motor special care has been given to mechanical simplicity and to the reduction of the number of parts, and that all combinations of gears, reducing motion and complicated valves have been avoided. Also in the construction of the motor the arrangements are such that access to any of the important parts can be had without taking the engine apart. The cylinder is carefully water jacketed on all sides, and is thus efficiently cooled no matter what the speed of the engine or the length of the run. In the arrangements for admitting the fresh mixture to the cylinder special care has been taken in the design to insure a uniformity of proportion, no matter what the speed of the revolution, and also to provide for certainty of ignition. The motor is governed through the admission valve wherein it



RUSS GASOLINE MOTOR.

controls directly the amount of fresh charge allowed to enter the cylinder. When running without a load the valve admits only so much of the mixture as may

be needed to keep the engine up to speed, while as the load increases the valve opens under and admits a larger charge until the limit of power is reached. These motors are made in sizes from 6 to 16 H. P. by the Russ Motor Company, of Brooklyn, N. Y., and it is claimed that due to an especial feature of design and construction they will maintain high efficiency for varying power and will operate continually and steadily for long periods of time with minimum wear and tear and expenses for repairs.

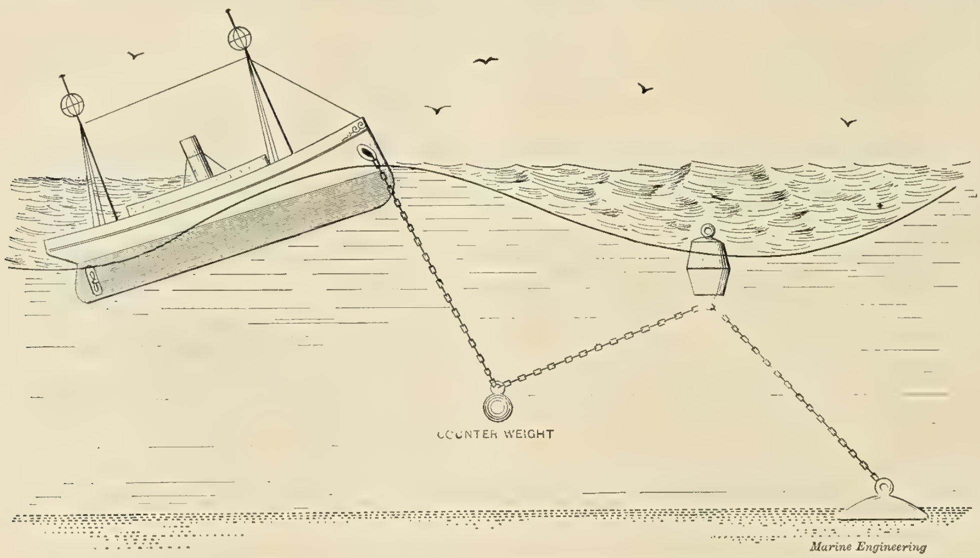


FIG. 1.—SAFETY ANCHORAGE FOR LIGHT VESSELS.

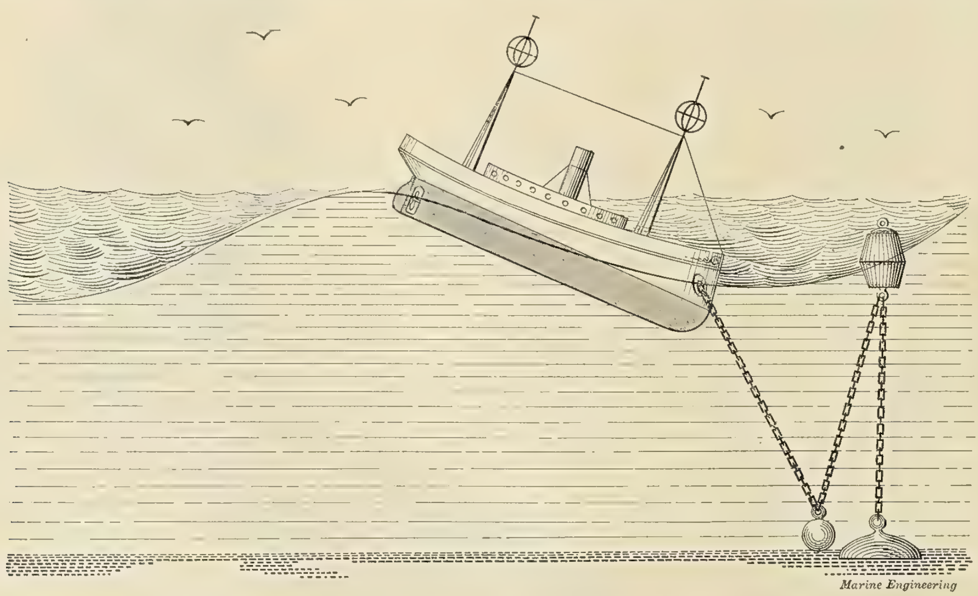
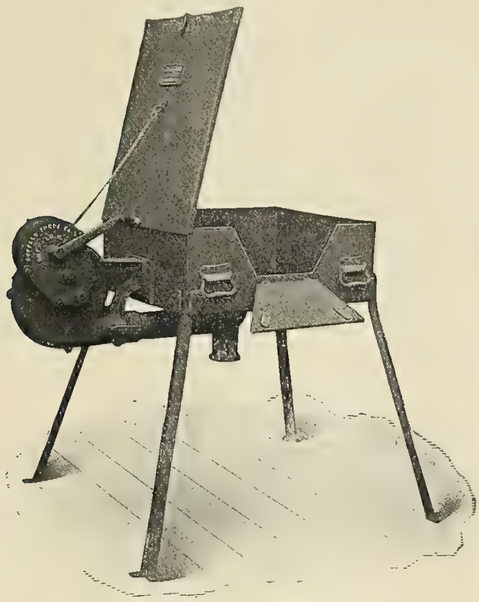


FIG. 2.—SAFETY ANCHORAGE FOR LIGHT VESSELS.

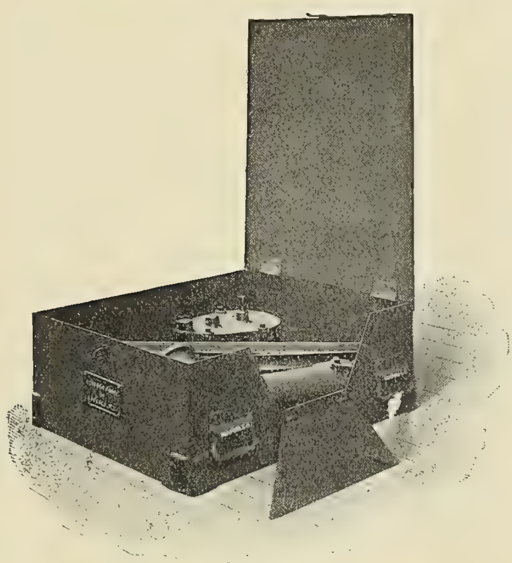
Safety Anchorage for Light Vessels.

The difficulty of keeping a light vessel on her station in every kind of weather, and the danger to navigation when she is shifted by stress of weather is recognized by all men who have to do with the sea. The same applies to buoys, which often drift away from their stations, that usually mark the entrances to channels, dangerous shoals and wrecks, and so deceive the mariner by their false position with which he is not acquainted. A mark which locates a dangerous spot when moved from its proper station can well be compared to a misplaced switch on a railroad. The results are the same—loss of life and valuable property. The strain put upon the cable of a light vessel or buoy in a heavy sea often causes it to part, and the mark is blown from its station. Frequently their anchors are lifted from the bottom as they ride each sea, and little by little the vessel or buoy is moved far from its original location. Thus when it is picked up by the navigator he gets a false bearing, and shipwreck is often the result. To prevent this possibility is the aim of the device represented

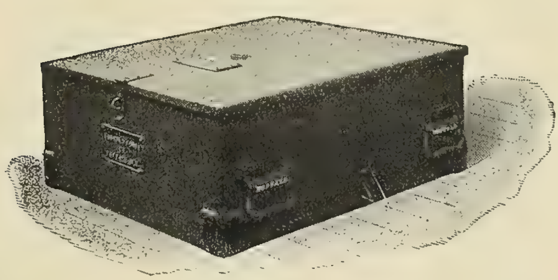
in the accompanying sketches. This device has been worked out by George C. Stanley, of Portsmouth, Va. It consists of a cable counterweight, buoy and anchor. In its operation, as wind or wave move the vessel from the charted position, the cable and counterweight are lifted; the weight of cable and counterweight is then suspended from the vessel to the buoy. As the strain increases the buoy is submerged and forms an elastic loop of the cable with a continuous strain throughout the movement. This allows the vessel to gradually recede with the wave, and as the tension is increased on the cable the vessel comes through the wave in an easy manner and presses forward to buffet the next wave without any sudden stress being placed upon its fastenings. The forces called into play by this anchorage are opposed to one another—the buoyancy of the float and the gravity of cable and counterweight. This method, the inventor believes, makes an elastic and safe anchorage, and allows the vessel to be moored with a short cable in a heavy sea, with the counterweight and buoy almost under the forefoot. The present method of anchorage requires a very heavy cable with many fathoms played out to relieve it from the sudden shock produced by each succeeding wave. Fig. 1 shows the light vessel upon the crest of a wave, with the greatest stress upon its cable and anchor, and the counterweight lifted from the bottom and buoy partly submerged. Fig. 2 shows the return of the vessel from the receding wave and its readiness for the next wave on account of the elastic tension placed on the cable by the float rising on the wave.



FORGE READY FOR USE.



CASE OPENED.



FORGE FOLDED UP.

Buffalo Army and Navy Forge.

In order to supply the rapidly increasing demand for a forge of minimum compass and weight, the Buffalo Forge Company, of Buffalo, N. Y., has recently placed upon the market a portable forge, which embodies many novel features. The forge, here illustrated and described, was designed primarily for use on battleships, cruisers, and merchant vessels. In view of the fact that in such situations space is an item of the utmost importance, the peculiar appropriateness of this forge will be at once recognized. The same features which render it invaluable for use on shipboard must likewise appeal strongly to those who have occasion to transport forges for long or short distances. Although the aim of securing extreme lightness, compactness, and consequent ease of transportation was paramount, those prime requisites of a first-class forge, capacity, durability and efficiency, have by no means been lost sight of. The characteristics thus referred to will be perceived by a glance at the three cuts herewith presented. The first view shows the forge as it appears when set up ready for use. The rigid steel-plate case provides a commodious hearth for the fire, which stands about 30 in. above the ground. To the case are removably attached the various parts, gearing, blower, tuyere and legs. The latter fit into sockets at each corner of the case and at their lower end are flanged horizontally to provide feet for support, as indicated in the first view. An 8 in. crank and handle furnishes the proper speed of rotation to the blast wheel of the blower through a train of four accurately cut gears, enclosed in a dust-proof case. The rotary blower is connected to the orifices in the circular tuyere plate by means of the tuyere pipe, which is formed with a short drop branch for the collection of ash. To facilitate the handling of long bars, a section on each side of the case is hinged so that it may be turned down. As in-

dicated in the second view, the several parts, gearing and blower, tuyere pipe, legs and crank, may be detached and readily packed within the case, leaving in addition sufficient space for blacksmith tools. The third view shows the forge in its most compact form, as it appears when ready for shipping and storage. This also is the form taken on shipboard when not in use. The outside dimensions of the closed case are but 27 1-2 in. by 22 1-2 in. by 10 in., and the weight of the complete outfit, 164 lbs. This is a very small compass in which to pack so bulky a machine as a forge. A hasp provides means for padlocking, and four handles, two on each side, make easy lifting a possibility. In addition the construction is such that the forge may be assembled for use in three minutes. This forge is already in extensive use, though by no means exclusively on shipboard. In addition to the sales in this country, the forge has been introduced abroad and is now in use in the Imperial Japanese Navy. It has likewise been recommended for army use by the quartermaster of the United States Army. It is, in fact, just the thing for transportation on mule back, or for compact storage and shipping.

Fracture of Tail Shaft S. S. Border Knight.

The skill and resourcefulness of marine engineers in making emergency repairs at sea have seldom been better displayed than in the case of the recent breakdown of the British S. S. *Border Knight*, owned by James Little & Co. We are in receipt of a report on this case which deserves a place in the annals of engineering breakdowns at sea. The chief engineer of the vessel, Alexander B. Gerrie, planned the method of repair, and the work was carried out not only under his direction, but with his aid, practically at the risk of his life.

The S. S. *Border Knight* is a steamship of 2,400 tons engaged in direct trade between New York and South African ports. She left the port of Durban, South Africa, June 9 last, and had a splendid run until July 2, when at 2.30 o'clock in the afternoon the tail shaft broke outside the liner and the propeller and taper end went to the bottom. All hands were turned out at once and steam worked back, and to each of the four engineers carried was assigned three helpers to carry out repairs. The Second Engineer started to get the guards off the shaft couplings and the bolts out, and in this work the Third gave assistance. The Fourth went to work to cut and bolt a piece of angle iron across the tunnel underneath the forward end of the intermediate shaft, and to cut up the channel iron which carried the wheel chains and bolt a section of it across the after end of the shaft. The after tanks were then pumped dry and the fore peak filled, but there was so pronounced a swell that it was not considered prudent to draw the tail shaft. To help matters it was decided to flood the forehold to a depth of 6 ft.

A 8 P. M. the engineers knocked off and then worked on watches until 6 o'clock the next morning. An examination of the available tackle showed that it was too light, consisting only of one 2-ton and one 1-ton tackles, while the tail shaft weighed four tons. Next the anchor stock of the kedge anchor was brought down to the tunnel for use as a ram to drive the coupling bolts. At the same time holes were drilled in the tunnel top to hang the tackle, and the gland at the after peak bulkhead was removed.

On the second day after the break the intermediate shaft was lowered, one end resting on the tunnel floor, and the other on the angle iron before mentioned. The tackles were then shifted ready for drawing the tail shaft, and at 9 P.M. every one was then sent to get a good rest until daylight.

On the third day the ship was dipping heavily, her head being kept to the sea by sea anchors. Chief Engineer Gerrie now had a plug made from a wooden fender to fit the stern aperture, and with this he was lowered over the side. Meanwhile the Second made preparations inside for withdrawing the tail shaft, and as he drew it inboard the Chief inserted the plug and made it tight, thus preventing any flooding or leaks. The tail shaft was drawn in past the channel iron, before referred to, and the channel was put up again and the weight of the shaft taken on it. One end was then lowered to the tunnel floor, and the other end having been heaved up by the tackle, the channel iron was taken down and the shaft lowered to the floor. The spare tail shaft was then gotten in place in the reverse manner and run out until it met the plug. The engineers worked all night getting the coupling bolts and everything in readiness for the final adjustment.

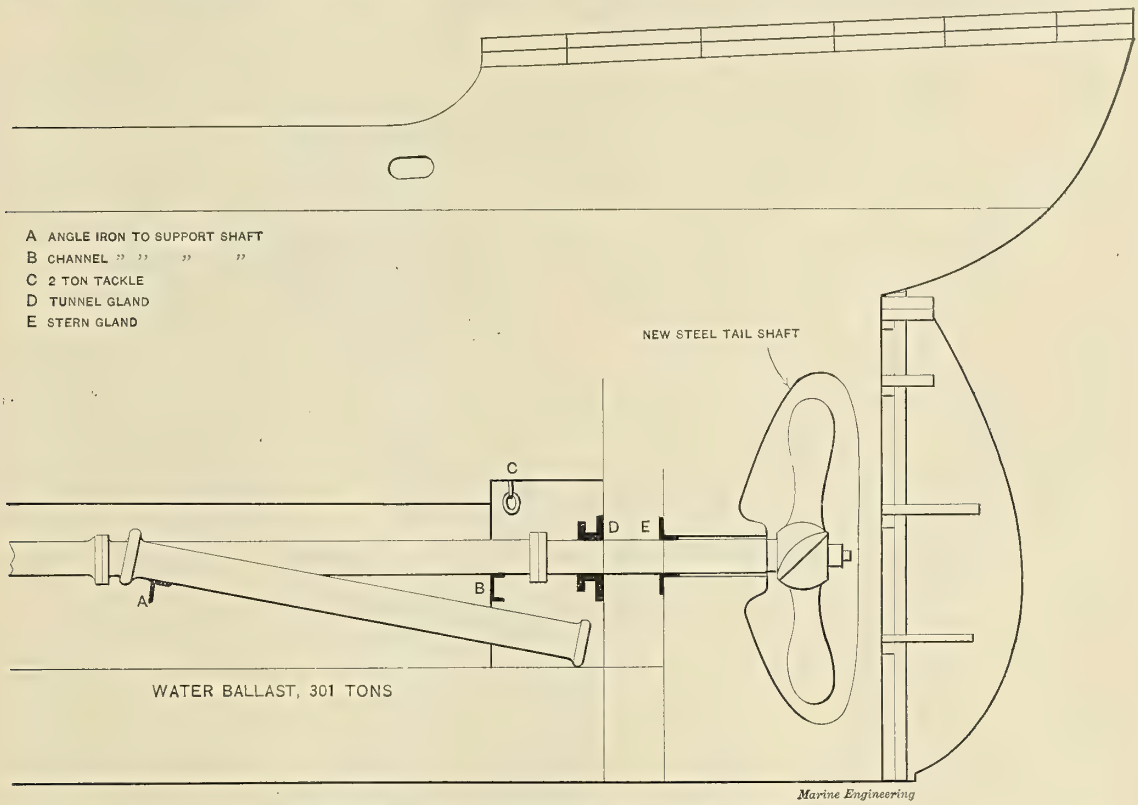
On the fourth day the tail shaft, having been protected at the outboard screwed end by wrappings of spun yarn, was pushed out flush with the boss and was ready for fitting on the propeller at 9 A. M. The propeller was now hoisted over the port side and lowered into the aperture in a very skillful and seamanlike manner by the deck department. As there was a nasty swell on, progress was slow and the work difficult and dangerous. Finally the propeller was centered in the aperture and the tail shaft pushed out, and after a good deal of effort the key was entered and the outside nut screwed on for two threads distance by about 6 P. M. All that night the engineers worked in the tunnel, coupling up the shafting and drilling the propeller spanner for a shackle.

At daylight on the fifth day the Chief Engineer was lowered down on the propeller with the propeller spanner, and with the aid of a wire purchase on the after winch tightened up the nut and got the pin in place ready for steaming. At 11 A. M. the sea anchor was taken in and the *Border Knight* proceeded under her own steam to St. Lucia, having been stopped only 4 days 3 1-2 hours.

The skill with which the repairs were effected is shown in the fact that no mishap occurred to the personnel—not even a crushed finger. While working outboard Chief Engineer Gerrie was frequently submerged, and so jarred that he bled freely from his ears and nostrils. There were sharks all about, too, and it was found necessary to catch four of them and chop them up to feed the others before work at the water line could be safely carried out. During the operations the Chief Officer of the ship was washed overboard and was rescued with difficulty—but on his return to the ship remained actively on duty.

As a result of his experience, Chief Engineer A. B. Gerrie is of the opinion that in such an emergency after the propeller is over the side and in the screw aperture, it would be better to take in the sea anchor and let the vessel roll so as to minimize the pitching, which naturally greatly delays the work.

At St. Lucia the vessel was viewed by Lloyd's Inspectors, who found everything in a tight and satisfactory condition, and upon their report the Lloyd's headquarters at London subsequently voted a special medal in recognition of his work in saving the vessel and crew. To Captain W. F. Splatt and Chief Officer Mathie special credit is given by Chief Engineer Gerrie for valuable services rendered during the work of repair.



ROUGH SKETCH SHOWING METHOD OF REPAIRS S.S. BORDER KNIGHT.

U. S. S. Wyoming.—The U. S. Monitor *Wyoming* was launched at the Union Iron Works, San Francisco, September 8. Miss Hattie Warren, daughter of United States Senator Warren, of Wyoming, performed the ceremony of christening. This vessel is one of the four single-turret, harbor-defense monitors, authorized by Act of Congress, May 4, 1898. She is of these dimensions: Length, l. w. l., 252 ft.; extreme beam, 50 ft.; mean draft, 12 ft. 6 in.; displacement, about 3,200 tons. She will be fitted with twin screw, triple-expansion engines, and Babcock & Wilcox water tube boilers. The estimated speed is 11 1-2 knots. The main battery will include two 12 in. breech-loaders, and four 4 in. rapid fire rifles. The armor varies in thickness from 11 in. on the side to 1 1-2 in. on the protective deck. The contract date of completion is March 5, 1901.

ACTION OF BILGE KEELS FROM A HYDRODYNAMICAL POINT OF VIEW.—I.*

BY G. H. BRYAN, F.R.S.

I.—INTRODUCTION.

(1) The means adopted for moderating the rolling of ships have been recently brought before my notice in a paper by W. J. Luke, and the discussions accompanying it in the Transactions of the Institution of Engineers and Shipbuilders in Scotland (XLIII. 2, 3) for December, 1899, and January, 1900. On reading this paper, I was much impressed with the efficacy of bilge keels in extinguishing rolling, as these appeared to furnish a beautiful practical illustration of the properties of discontinuous motion which have for many years been a favorite subject of study among applied mathematicians. I at once wrote to Dr. Elgar, inquiring how far the theory of the bilge keel had been treated from a hydrodynamical point of view, and, at his suggestion, the following paper has been prepared, in the hopes that a theoretical discussion of the principles underlying the use of the bilge keel may prove of use in any further experiments that may be undertaken. In Sir William White's paper of 1895 allusion was made to the investigations then about to be undertaken by R. E. Froude, but from Mr. Luke's paper (page 23) it appears that an account of these had not yet been published.

(2) The primary object to be kept in view in every device for extinguishing the oscillations of a ship is

*Read before the Institution of Naval Architects, London.

the absorption or dissipation of the energy of the oscillatory motion. The use of internal water-chambers communicating with one another by a large number of small holes as described by Mr. Watts in 1883 and 1885 affords an excellent illustration of this property. In consequence of the resistance offered to the flow of water from one chamber to the other and back, energy is absorbed from the water and is ultimately converted into heat in much the same way as in Joule's classical experiment of determining the so-called mechanical equivalent of heat.

With the use of bilge keels, the energy of oscillation has to be absorbed by the water surrounding the ship; and there are three ways in which a fluid can absorb energy:—(1) By viscosity; (2) by the production of discontinuous motions; (3) by the generation of waves. Now, the effects of viscosity may naturally be expected to manifest themselves more in retarding the motion of the ship than in extinguishing oscillation, and the fact that bilge keels do not increase the resistance on the ship to an appreciable extent shows that their action cannot primarily be due to viscosity. As to the effects of viscosity in determining the ultimate form of the dissipated energy, these are of no great importance to the naval architect.

We are thus left to deal with discontinuous motion and wave motion. The question as to the relative extent to which the action of bilge keels depends on these two causes may not be devoid of practical interest. It is clear that a ship which readily expends its oscillatory energy in forming waves may, under other conditions, all the more readily absorb energy from certain types of waves, on somewhat the same lines as, in the radiation of heat, good radiators are good absorbers; in other words, a ship which generates the most waves when it rocks is the most easily set in motion when waves of the proper period strike it.

(3) The object of this paper is to show that the efficacy of bilge keels in extinguishing rolling motion, in virtue of the discontinuous motions they produce, is materially greater than would be directly inferred from experiments on the co-efficient of resistance of a lamina moving in water. It must be clearly borne in mind throughout what follows that we are not considering the total extinctive effects, but merely the amounts by which these are increased by the addition of bilge keels to a ship which previously did not possess them. In a ship unprovided with bilge keels and possessing no sharp edges projecting into the water, discontinuous motions cannot exist at the velocities due to ordinary moderate rolling motions. In such cases the extinction of oscillation is doubtless due to wave formation, aided to some extent by viscosity. But when a bilge keel is added with a sharp edge, discontinuous motion is at once set up, the fluid motions being divided into two parts by a surface of discontinuity thrown off from the sharp edge, and it is my purpose to prove that the advantage of the ship with bilge keels over the same ship without them can be accounted for by discontinuous motions to a greater extent than would appear at first sight probable. It is not contended that the effects of wave motion are not also of importance in this connection, but they probably are secondary in character, their action being due to the influence of the waves in modifying the discontinuous motions, as well as to the presence of the bilge keels causing a modification in the waves by which their absorption of energy may be materially increased.

For this reason wave motion has been entirely left out of account in the calculations which I have made, a simplification which is, moreover, necessary in order to bring the problem within the range of existing methods of mathematical analysis. At the conclusion of the paper I propose to indicate lines on which experiments might be conducted with a view of putting the matter to a practical test.

(4) Sir William White tells us that the late Mr. Froude's experiments made with a paddle oscillating in water gave a co-efficient resistance of 1.6 lb. per square foot, with a mean velocity of 1 ft. per second, and that the use of this co-efficient does not fully account for the experimental facts. "On the other hand," Sir William White goes on to say, "in the case of the *Sultan*, the agreement between Mr. Froude's estimate, based on the use of this co-efficient and the experimental facts, was very close indeed."

Now the diagram shows that the midship section of the *Sultan* is *rounder* than that of the *Revenge;* and, moreover, the bilge keels were placed one near the bottom, and the other rather below the point where the contour is most curved. The section given of the *Revenge* shows that the submerged portion is more nearly of the form of a *rectangle* with rounded corners; and, moreover, the bilge keel is placed at the most protuberant part of the contour. In Mr. Luke's diagrams the angular forms of the midship sections of most ships and the far more nearly circular section of the *Sultan* are noticeable, while in diagrams of the *Campania* and *Omrah,* kindly sent me by Dr. Elgar, the section is approximately a rectangle with the corners rounded off. A glance at the diagrams suggests that the differences in the behavior of the bilge keels largely depend on the forms of the midship sections, and we are thus led to the following proposition:

The resistance to discontinuous motion due to bilge keels is greater in a ship of somewhat angular section than in a ship of circular section, provided that the keels are attached at the protruding corners of the section.

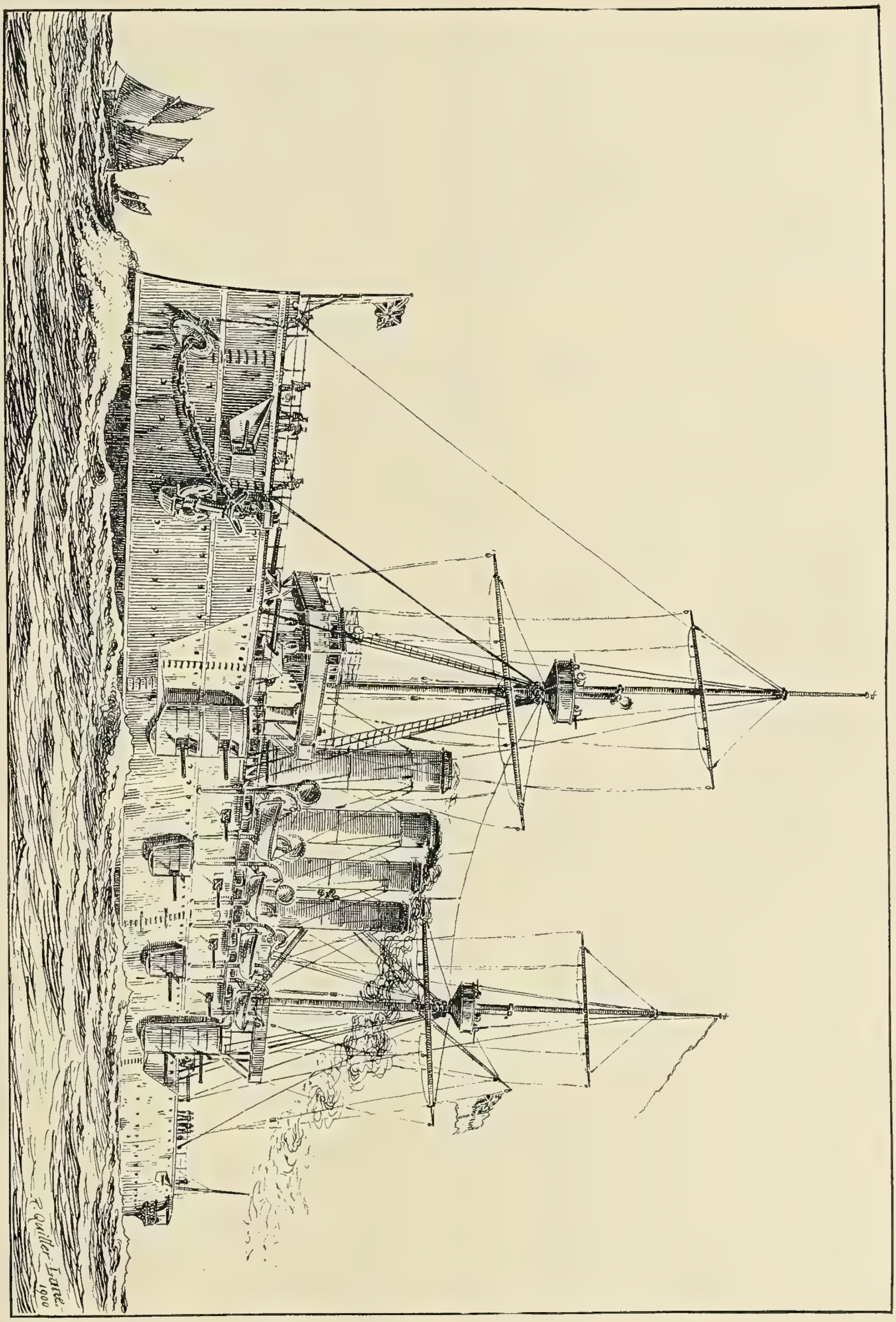
(5) The angular contour of the midship section increases the efficacy of the bilge keel in two distinct ways:

(*a*) The motion of the ship produces currents in the water which flow past the bends in the opposite direction to that in which the ship is turning, thereby producing an increase of pressure on the bilge keels.

(*b*) The discontinuous motion past the bilge keels alters the distribution of pressure on the sides of the ship, and for a rectangular section the differences of pressure thus produced have a moment always tending to retard the rolling motion.

Sir William White was evidently alluding to some such consideration as these in his remark:—"But, as

the matter at present stands, it would appear that the *Revenge* experiments point to a possibility which is also indicated by the results given by Mr. Froude in 1874. It appears that when bilge keels are added to a ship they must become effective, not merely as flat surfaces oscillating with the ship, and experiencing direct resistance, but by indirectly influencing the stream-line motions which would exist about the oscillating ship if there were no bilge keels."



FIRST-CLASS SHEATHED ARMORED CRUISER ABOUKIR, 12,000 TONS DISPLACEMENT, FOR BRITISH NAVY.

British Armored Cruiser Aboukir.

A fine example of an armored cruiser of a type now building for the British Navy is shown in the accompanying sketch of H. M. S. *Aboukir,* recently launched from the Fairfield yard at Govan on the Clyde. This vessel is a first-class steel, sheathed, armored cruiser of these dimensions: Length, 445 ft.; beam, 69 ft. 6 in.; mean draft, 26 ft. 3 in.; displacement, about 12,000 tons. The *Aboukir* will be fitted with twin screws driven by

triple expansion engines, with cylinders 36 in., 59 in., and (two) 68 in. dia., and 4 ft. stroke, of 21,000 collective horse-power. Steam will be furnished by thirty Belleville water tube boilers fitted with economizers arranged in four groups, each group fitted in a separate water-tight compartment. The boiler pressure will be 300 lb., reduced at the engines to 250 lb. The estimated speed is 21 knots. For protection the *Aboukir* will have an armor belt of 6 in. nickel steel for 230 ft. of her length and 11 ft. 6 in. deep. Harveyized steel 12 in. thick will be used for the conning tower, and the barbettes will be protected with 6 in. armor. Bulkheads will be of 5 in. nickel steel, and the protective deck will have a maximum thickness of 3 in. The armament will include two 9.2 in. and twelve 6 in. guns, also fourteen 12-pounders, besides several boat, field, machine, and automatic guns. There will be two 18 in. submerged torpedo tubes, fitted broadside. The complement is 750 officers and men.

San Francisco Dry Dock.—The proposed new graving dock to be built at Hunter's Point, in San Francisco harbor, will be operated by the San Francisco Dry Dock Co., which has taken over all the dock interests of the old California Dry Dock Co. These include an existing graving dock, in dimensions: Length, 490 ft.; beam, 125 ft.; depth, 24 ft.: also two floating docks of 3,000 tons and 1,200 tons capacity, respectively, and a marine railway capable of handling any vessel up to 800 tons. The new dock will be excavated in the solid rock, which at the Point is green serpentine. The plans call for a dock 750 ft. long, 122 ft. wide at the coping, 74 ft. wide at bottom, 32 1-2 ft. deep over sill below coping, and with 28 ft. of water at high tide. In dimensions, therefore, the dock will be one of the largest in existence. Concrete will be used for the interior facing of the dock, and granite for the approach and seat for the caisson. The keelson and working floor will be of Douglas fir well anchored and embedded in a sub-floor of concrete. The entrance to the dock will be closed by a steel floating caisson, which measures, length, 104 ft.; beam, 28 ft.; depth, from bottom of keel to underside of upper deck, 33 ft. 9 in. Wharf approaches on either side of the entrance to the dock will be constructed by piling, and will be about 200 ft. long and 60 ft. wide. The pumping plant will consist of three centrifugal pumps, each having a 38 in. discharge. The combined capacity of these pumps is 110,000 gal. per minute. They will be arranged with double suctions, so that they can empty both or either of the dry docks. Two hours is the estimated time for emptying the new dock, and forty-five minutes the old one. Three Corliss engines, 24 in. by 48 in., and each of 345 H. P., will operate the pumps by the rope drive, the engines being located on the surface and the pumps in a pit on a level with the bottom of the dock. Steam will be supplied by six water tube boilers, and there will also be a 75 H. P. donkey boiler for furnishing steam to the drainage pumps and power capstans. A brick stack 110 ft. high and 7 ft. inside dia. will be put up on the boiler house. The officers of the dock company are: President, William Babcock; Vice-president, J. H. Meyer; Secretary, W. F. Russell. Howard C. Holmes is the engineer in charge of the work.

LAUNCHES—HOME AND FOREIGN.

S. Y. Lysistrata.—The large full-powered, sea-going steam yacht *Lysistrata*, for James Gordon Bennett, owner of the *New York Herald*, was launched from the Denny yard, at Dumbarton, on August 28. This vessel is of the following dimensions: Length on waterline, 285 ft.; length over all, 314.5 ft.; breadth, extreme, 39.9 ft.; Thames tonnage, 2,082. She has a straight stem and long stern, and there is a full poop aft, a long shade deck amidships, and a short turtle-back forward. Unlike other large yachts, she has only one mast, which is placed aft of the funnel, and has a short yard for signaling purposes only. On the shade deck there are two deckhouses. The after one contains a large smoking-room with a vestibule, from which a stair leads to the main deck. The forward one contains a private business-room and state-room for the owner, and a chart-room. Above this deckhouse is the navigating bridge. Under the shade deck there is a long range of deckhouses. At the forward end of this is the dining-room, a state-room with dressing-room, bath-room, and a Turkish bath-room. From here also a fine stairway leads to the private staterooms below. Between the engine and boiler casings the galley and pantry are situated, and at the after end of this deckhouse there are six comfortable state-rooms with bath-rooms attached. Under the poop deck are crew's galley, cow-house, officers' and crew's lavatories and w.c.'s. On the lower or cabin deck forward are five large state-rooms (one of them 20 ft. sq.), with dressing-rooms and bath-rooms adjoining. Forward of these there are a number of rooms for private servants. The officers and crew have fine accommodation on the cabin deck aft. Ample store-rooms and refrigerating-rooms are provided for the owner in the forward hold, and similar rooms for the officers and crew aft. The machinery of the yacht consists of two sets of four-crank triple-expansion engines, and four single-ended boilers of the cylindrical multi-tubular type, with a donkey boiler of the same type. She has ample coal bunkers, and it is intended she should attain a high speed. She will be lit throughout with electric light.

S. S. City of Rockland.—The cargo and passenger steamer *City of Rockland*, for the Boston & Bangor Steamship Co., was launched at the McKie shipyard, in East Boston, September 11. The new vessel is a side-wheel steamer of these dimensions: Length, 300 ft.; beam, 30 ft. over hull, and 62 ft. over guards; depth of hold, 14 1-2 ft. She will be fitted with a beam engine, constructed by the W. & A. Fletcher Co., of Hoboken, N. J. This engine will have a cylinder 63 in. dia. and 122 in. stroke, of about 1,700 horse-power. The side-wheels will be of the feathering type, 25 ft. in dia., and 10 ft. face. There will be accommodations for a large number of passengers in 200 state-rooms and parlors. The vessel is built of oak. It is expected she will be on her station next May.

Sch. Thomas S. Dennison.—The wooden four-masted schooner *Thomas S. Dennison* was launched from the Dunn & Elliott yard, at Thomaston, Me., on August 25. The vessel is of these dimensions: Length, 218 ft. 2 in.; beam, 43 ft. 7 in.; depth, 19 ft. 7 in. The vessel has a capacity of about 2,000 tons.

I. R. C. Nowik.—At the Schichau yard in Dangzig, on August 15, the Russian Cruiser *Nowik* was launched. This cruiser has a length of 347 ft. 8 in., a beam of 40 ft., and on a draft of 16 ft. 5 in. will have a displacement of about 3,000 tons. The bunker capacity is 500 tons, and will insure a radius of action of about 6,000 miles. This vessel has triple screws, and three engines of 18,000 collective I.H.P. This is expected to give a speed of not less than 25 knots. On account of her high speed the *Nowik* will be chiefly used as a scout and dispatch vessel. She will have three funnels and a signal mast, with fighting-top and signal yard, as well as three large electric searchlight projectors. The vessel is fitted with a heavy protective deck, and will have the following armament: Six 12 cm. and six 4.7 in. quick-fire guns, one Baranowsky gun, and six torpedo tubes, with three 8 mm. machine guns in the fighting-top.

Sch. Geneva.—The four-masted schooner *Geneva* was launched at the yard of Cobb, Butler & Co., of Rockland, Me., on September 20. She is of these dimensions: Length, 190 ft. 6 in.; beam, 37 ft. 2 in.; depth, 17 ft. 5 in.; net tonnage, 776 tons, carrying capacity, 1,300 tons. The vessel has two full decks and poop deck extending forward to the mainmast. Her masts are of Oregon pine and are 92 ft. in length She is owned by John S. Emery & Co., of Rockland, Me., and has been chartered to load a cargo of coal at Baltimore, for Pernambuco, Brazil.

Sch. J. Edward Drake.—The four-masted wooden schooner *J. Edward Drake* was launched at the yard of the New England Co., Bath, Me., on September 11. The vessel measures: Length of keel, 190 ft.; beam, 37 ft.; depth, 17 ft.; gross tonnage, 910 tons. The keel is of oak, the frames of hackmatack and other hardwoods, the ceilings of pine, and the planking of yellow pine. The vessel is fitted with two discharging hatches 11 ft. sq. She is also fitted with a Hyde windlass outfit. She is owned by James B. Drake, of Bath, Me.

S. S. Canadian.—The S. S. *Canadian* of the Leyland Line, was launched on the Tyne, England, August 11. This vessel is of the following dimensions: Length, 550 ft.; beam, 59.6 ft.; depth of hold, 47 ft. She is fitted for general cargo and cattle carrying trade, having accommodations for 820 live stock. She will also have passenger accommodations for about 100 cabin passengers. The vessel will be put in service on either the New York or Boston route of the company. Her speed will be about 15 knots.

Sch. Thallium.—The schooner *Thallium* was launched from the yard of McKay & Dix, Bucksport, Me., on August 23. She is of the following dimensions: Length, 164.3 ft.; beam, 36.6 ft.; depth, 16.7 ft.; gross tonnage, 729.28. She was built expressly for the cryolite carrying trade between the Greenland mines and Philadelphia. The vessel is owned by Capt. C. B. Dix, of New York.

Tow Barge.—One of the four lime barges for the Rockland, Rockport, Lime and Cement Co., ordered from the Harlan & Hollingsworth Co., of Wilmington, Del., was launched from their yard, August 23.

T. S. S. Justo Chermont.—This steel twin-screw vessel for the Amazon Navigation Co., was launched from the yard of Laird Brothers, Birkenhead, August 25. The vessel is of these dimensions: Length, 230 ft.; beam, 35 ft. 6 in.; depth, 11 ft. 9 in.; cargo capacity, 300 tons on 7 ft. 6 in. draft; speed, 13 knots. She is to have two sets of triple-expansion engines, and two steel double-ended return tube boilers, built for 175 lb. working pressure. A sister vessel, the *Campos Salles* was recently completed by the same builders for the same service.

Tug Oscar G. Murray.—The steel tug *Oscar G. Murray*, for the Baltimore & Ohio Railroad, was launched at the yard of the Spedden Shipbuilding Co., of Baltimore, September 15. The tug is of these dimensions: Length, 105 ft.; beam, 22 ft.; depth, 12 ft. 6 in. She will be fitted with a fore and aft compound engine, with cylinders 20 in. and 40 in. by 28 in. The vessel is named after the first vice-president of the Baltimore & Ohio Railroad Co.

Dredge.—The vessel, said to be the largest dipper dredge in America, was recently launched at the St. Lawrence Marine Railway Co., Ogdensburg, N. Y. She is of the following dimensions: Length, 115 ft.; beam, 40 ft.; drawing 12.2 ft. at working end and 10 1-2 ft. at stern. She is to be taken to Massena to cut a channel in the proposed canal through from the St. Lawrence to the Grasse River.

Sch. John W. Dana.—The three-masted wooden schooner *John W. Dana* was launched from the yard of F. S. Bowker, Phippsburg, Me., August 25. The vessel was built for the West Indian trade, and is of these dimensions: Length of keel, 153 ft.; beam, 34 ft.; draft, 13 ft.; carrying capacity, about 1,000 tons. She is owned by John W. Dana, of Portland, Me.

Sch. Medford.—The four-masted schooner *Medford* was launched from the yard of Kelly, Spear & Co., of Bath, Me., on August 29. She is of the following dimensions: Keel, 190 ft.; beam, 40 ft.; depth, 23 ft.

Freight Lighter.—A large freight lighter, the last of an order for five for the Baltimore & Ohio Railroad, was launched September 11, at the yard of William N. Skinner & Sons, of Baltimore.

Barge Theodora Palmer.—The wooden barge *Theodora Palmer*, of 3,000 tons capacity, for the Thames Towboat Co., was launched from the Noank shipyard, Noank, Ct., August 25.

S. S. St. Paul.—On a recent west bound trip, the American liner *St. Paul* made the passage from Cherbourg to New York in 6 days, 7 hours and 6 minutes, beating her own record and that of all other liners on the route, with the exception of the two new German fliers. On the way across, the *St. Paul* passed the Cunarder *Campania*, and docked in New York considerably ahead of that vessel.

A preliminary trial in the Kennebec River, the U. S. torpedo boat *Barney*, 167 tons displacement, built by the Bath Iron Works, is reported to have shown a capacity for high speed. The contract speed is 28 knots.

On a recent trial the Parsons turbine driven destroyer *Cobra* is reported to have attained a speed of 37.7 knots.

Obituary.

Arthur Sewall, shipbuilder and shipowner, of Bath, Me., died at his summer residence at Small Point, near that city, September 5. He was a native of Maine, having been born in Bath, in 1835. In that city he received his education, and when he left school he entered his father's shipyard, then one of the largest on the coast. In 1854 Mr. Sewall associated himself with his brother Edward, in shipbuilding and shipowning enterprises, under the firm name of Arthur Sewall & Co. To the efforts of this firm are in large measure due the existence of the American flag in the foreign freight trade. In 1894, the firm built the first steel sailing ship constructed in this country, the material being specially imported for the purpose. Later, other and larger vessels were built from domestic materials. Deceased was honored by the nomination for Vice-President of the United States on the Democratic ticket in 1896, a place which he had not sought. His death removes one of the strongest supporters of the American foreign shipping interests A widow and two sons, Harold M. and William D. Sewall, survive.

Robert W. Linn, one of the pioneer builders of wooden vessels on the Great Lakes, died in Detroit last month, aged 70 years. He came to this country originally from Scotland, and first engaged in the shipbuilding business at Gibraltar, Mich. At one time deceased had as a partner Mr. Craig, now of Toledo, Ohio. No vessels have been built at the Gibraltar yard for several years.

Turbine Driven Vessels.—It is not improbable that the turbine motor may be applied to passenger service in the near future. In the Channel service, between England and Ireland and England and the Continent, high speed seagoing vessels abound. The London, Brighton and South Coast Railway has under construction plans for a Parson's turbine driven vessel for the Newhaven-Dieppe route. Another large corporation, the London & North Western Railway Co. is understood to be contemplating the use of the turbine motor in the projected steamer *Scotia* for express service between Holyhead and Dublin. In both of these cases it is more than likely that the hulls would be built at the Denny yard at Dumbarton, on the Clyde. The success which has attended the trials of the destroyers *Viper* and *Cobra* has done much toward making the turbine driven vessel a possibility. The last named vessel built by Armstrong, Whitworth & Co. on the Tyne, on speculation, has recently been purchased by the British Admiralty.

Water Tube Boilers.—A strong committee has been appointed for the purpose of investigating the boiler question in the British Navy under the presidency of Vice Admiral Sir Captain Domville, R. N. The membership includes superintending engineers of large lines of merchant vessels, a scientist and a member of the engineer corps of the Royal Navy. The committee will carry out a very exhaustive inquiry into the merits and demerits of the Belleville water tube boiler for naval purposes as compared with the cylindrical tank boiler. Other forms of boiler will be considered and also the important question of auxiliaries. Practical and experimental trials will be conducted.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—(1) As I understand it, the resistance makes the field coil get hot, and in order to avoid the heating more wire is added to the field; now, if resistance is what heats the coils, how do you account for coolness of the field after adding more wire, consequently more resistance?

(2) What is the cause of the humming in the fields and pole pieces of an induction motor, when the armature is not revolving, but the current is passing through the fields?

(3) What changes are necessary to reverse the running of an induction motor? Crossing the positive and negative wires at binding-post will not do it.

L. C. S.

A.—(1) The resistance is not what makes the field coil get hot. What heats it is the energy required to force the current through the wire against the resistance, and this energy is equal to the resistance multiplied by the square of the current, the resistance being measured in ohms and the current in amperes. If the resistance is increased the current is reduced, and as the square of the latter enters into the multiplication the product is reduced To illustrate, suppose the resistance is 100 ohms and the current is 2 amperes, then the energy expended in heating the field coil will be $2 \times 2 \times 100 = 400$ watts. Now, if the field resistance is increased to 200 ohms, the current will be reduced to 1 ampere, and the energy expended in the field in developing heat will be $1 \times 1 \times 200 = 200$ watts

(2) The cause of the humming, when the armature is not revolving, is that under such conditions the iron is subjected to two strong magnetizing forces which act in opposite directions, or pull against each other, so to speak, and this action produces a very rapid vibration of the metal, which results in developing a humming noise.

(3) To reverse a two-phase induction motor, reverse the two wires of one circuit, leaving the wires of the other circuit unchanged. To reverse a three-phase induction motor, reverse any two wires.

Q.—Will you please answer the following question: If 80 gallons of feed water per minute at 180° pass through a coil heater of 3,050 sq. in. heating surface, heated to 370°, at what temperature will it enter the boiler?

A Subscriber.

A.—No exact answer can be given to this question by any process of mere computation. The result will depend on many other conditions which are not stated, and which cannot be definitely known. The chief of these are: (1) The character and condition of the surfaces in the heater, whether clean or coated with scale or grease. (2) The arrangement of the coils in the heater with reference to the velocity of circulation, recent experiments showing that the efficiency of a feed heater is to a considerable extent dependent on this feature. Making the best estimate possible regarding these various points, however, it is not likely, under the conditions stated, that 1 square foot of the surface will transfer more than about 600 heat units per minute. The heater as a whole has about 21 sq. ft of surface, and this would give $21 \times 600 = 12,600$ heat units transmitted through to the water. Taking 8 lb. to the gallon, we have this amount of heat absorbed by 640 lb. of water. This gives a rise of temperature of $12,600 \div 640$, or about 20 degrees. This estimate might, however, widely vary under different conditions.

It will be noted that the heater mentioned is entirely too small for this quantity of water, which amounts to about 38,400 lb. per hour. This is enough for a modern 2,500 I.H.P. triple-expansion engine, while 21 sq. ft. of heater surface would mean only a little vest-pocket heater, say about 12 in. dia. by 24 in. long.

On the recent trial trip of the U. S. S. *Alabama*, over the Cape Ann course, an average speed of about 17 knots was maintained.

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U. S. BATTLESHIP WISCONSIN EXCEEDS 17 KNOTS SPEED ON OFFICIAL TRIAL.

On her trial last month the battleship *Wisconsin* attained a maximum speed of 18.54 knots, and her average rate for 32 knots was 17.9 knots, the average for the entire trial figuring out 17.1 knots, subject to tidal corrections. Thus again has the Pacific coast demonstrated that it can turn out war vessels which are the peers of any constructed elsewhere in the world. This fine fighting ship came into being at the birthplace of the famous *Oregon*, the Union Iron Works, San Francisco, and now that her trial has been successfully run she will doubtless soon be added to the list of fighting ships in commission. The *Wisconson* is classed as a sea-going coast line battleship, and is of these dimensions: Length on load water line, 386 ft.; beam extreme, 72 ft. 2 1-2 in.; draft mean, 23 ft. 6 in.; gross tonnage, 6,802 tons, and displacement with two-thirds ammunition and stores aboard, 11,525 tons. Her designed speed was 16 knots with 10,000 I.H.P. Her construction was authorized by Congress in the act of June 10, 1896, and the contract for her construction was signed September 19, 1896. On February 9, 1897, the keel was laid, and on

U. S. BATTLESHIP WISCONSIN, BUILT BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.

October 11, 1900, the official trial was run. From an inspection of the photograph reproduced on our frontispiece, the handsome appearance of the vessel will be noted. She has a high freeboard forward and amidships, and has a pronouncd ram bow, and little or no shear. The masts extending upward from the fighting tops are for signal purposes only, and the two smoke pipes are abreast, differing in this respect from most of the other ships in commission. Altogether she has a very trim and fighting appearance. Her chief weapons of offense, the four 13-in. guns, are carried in pairs in two turrets, one turret forward and one aft, and in addition she has fourteen 6-in. rapid-fire guns, sixteen 6 pdrs., and four 1 pdrs., besides various machine and landing guns. There are also four torpedo tubes for the long Whitehead torpedoes. The armor protection ranges from 16 1-2 in. on the sides, 15 in. on the barbettes, 14 in. on the turrets down to 2 3-4 in. on the flat of the protective deck.

Earlier in the month, what might be called an endurance test of the vessel was carried out on a run down the coast from Seattle to San Francisco. On this trip she covered 806 knots in 59 hours, making an average speed of about 14 knots. During this run the machinery worked without the slightest hitch.

Subsequent to the official trial of the *Wisconsin*, congratulatory telegrams, referring to her performance, passed between various heads of the Navy Department in Washington, and the builders in San Francisco.

The contract price of the hull and machinery was $2,674,955. When in commissioin her complement will be 40 officers and 449 men.

Work at Sparrow's Point.—Work in the marine department of the Maryland Steel Co. is very brisk just now. There are orders on hand for eleven new vessels, and for repairs to four old ones. The displacement of the new ships reaches 97,000 gross tons, and the horse power is 50,000 I. H. P. The number of engines to be built is nineteen, and of boilers fifty-two. Contracts for the two new steel freight steamers for Kidder, Peabody & Co., of Boston, call for two vessels of the following dimensions: Length over all, 505 ft.; between perpendiculars, 490 ft.; beam, 58 ft.; depth, 40 ft. They will be built to conform to the British Corporation shelter deck class of the highest rating. Each vessel will have engines of 4,000 I. H. P., and four boilers fitted with Howden draft, built for a working pressure of 20 lb. per sq. in. The speed will be 12 knots loaded. The dead weight capacity at 27 ft. draft is 11,200 tons, cargo and coal. These steamers will be operated by the newly organized Boston Steamship Co., of which Alfred Windsor is president.

On a preliminary trial of the U. S. destroyer *Bailey* in the Hudson River the machinery worked very satisfactorily. This vessel was built by the Gas Engine & Power Company & Charles L. Seabury Company, Cons., at their Morris Heights yard on the Harlem River. She is fitted with triple expansion engines and Seabury water tube boilers. This vessel is one of the three destroyers authorized by act of Congress of March 3, 1897. The others are the *Stringham* and the *Goldsborough.*

S. Y. ARROW DESIGNED TO STEAM AT THE RATE OF 40 KNOTS.

The fastest vessel afloat is always an object of special interest to the naval architect and marine engineer, and for this reason, alone, the following description of a vessel designed to capture the blue ribbon for speed will claim attention. This vessel is the twin-screw yacht *Arrow*, designed by Naval Architect Charles D. Mosher, of New York, for Charles R. Flint, also of New York. In commercial circles throughout the country Mr. Flint is widely known as a member of the South American export firm of Flint, Eddy & Co., in addition to many other financial and commercial interests.

The *Arrow* is undoubtedly the most notable recent example of a boat intended to attain the highest possible speed. To achieve such results it has, of course, been necessary to make use of the most advanced and refined features of engineering practice, in the design and construction of both the hull and machinery. In this class of work the designer has had unusual experience, for it will be recalled that Mr. Mosher was responsible for the results attained with the steam yachts *Yankee Doodle, Norwood, Feiseen, Presto* and *Ellide.*

In the case of the *Arrow*, the problem which presented itself for solution was, first, the design of a form of boat suitable for the development of extreme speed, and, second, the construction of the boat and contained machinery with a minimum of weight of materials. While speed was the primary consideration, however, comfort for those carried was not lost sight of, and, indeed, this has been considered and worked out to the point of luxury. The accommodations are not "crowded" by the space necessary for the machinery equipment, as might be supposed, for there will be sleeping accommodations on board for twenty-five persons. The machinery necessarily occupies a considerable amount of space, but by care in design this has been reduced to remarkably small compass considering the size of the plant—there are twenty-two steam cylinders on the yacht.

In the accompanying engravings the artist's idea of the boat steaming at top speed at sea is clearly displayed, and in the exact, if less picturesque, drawings the construction of the yacht and of her engines and boilers can be most clearly understood.

The chief dimensions of the *Arrow* are as follows:

Length, extreme	130 ft. 4 in.
Length, on water line	130 ft. 0 in.
Beam, extreme	12 ft. 6 in.
Normal draught of hull	3 ft. 6 in.
Draught under screws	4 ft. 7 in.
Depth amidships	9 ft. 4 in.
Displacement, normal draught of...3 ft. 6 in.,	67.66 tons
Coal bunker capacity	17 tons
Water tank capacity	1,500 gals.

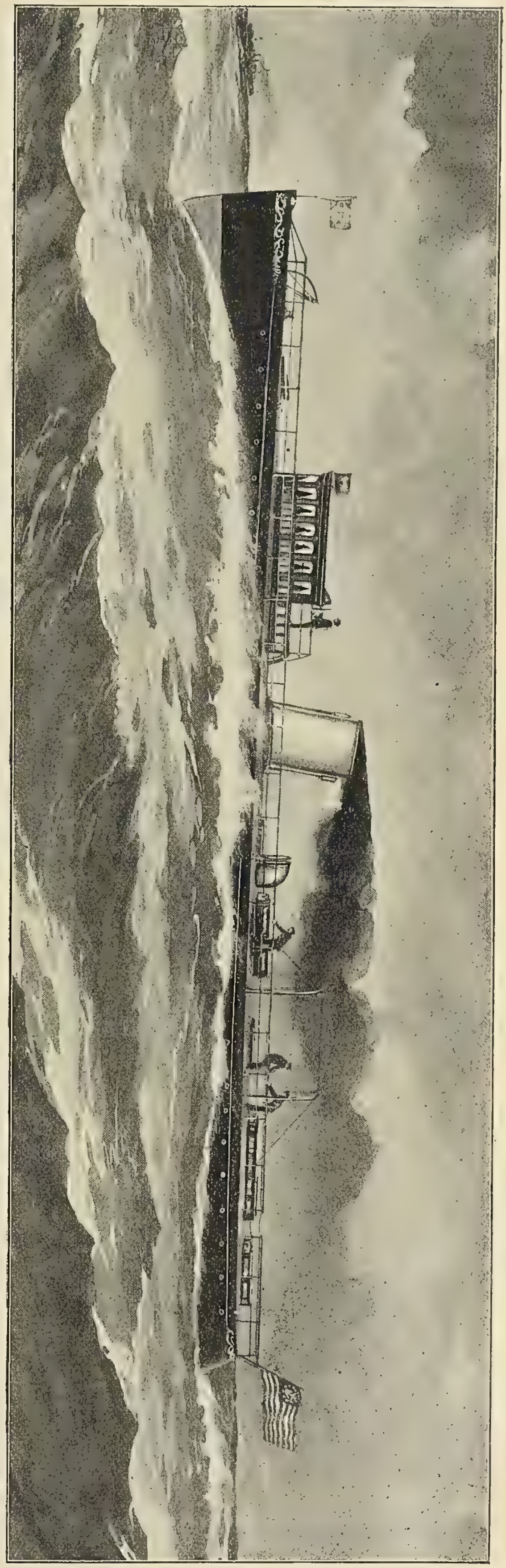
This boat is fitted with six transverse water-tight bulkheads, dividing the hull into seven compartments, as follows: 8 ft. abaft the bow is a collision bulkhead, the compartment forward being used for a trimming tank, and providing a large storage reservoir for fresh water. As shown in the plans the crew's quarters are situated next abaft the collision bulkhead, and extend the full width of the vessel for 15 ft. of its length.

Ample accommodations and folding berths, lockers, toilet, are provided for twelve men.

Next to the crew space are located the officers' quarters, consisting of a double state room, which is also the full width of the boat, and 7 ft. 6 in. long. It contains a desk, two extra folding berths, two large clothes presses, bureau, with ample drawers, and toilet equipment. Between the officers' quarters and the bulkhead at the forward end of the boiler space is the galley, which occupies the full width of the vessel for a length of 10 ft. 6 in. This is provided with a large range, spacious ice chest, ample closets, sink, table, sideboard, fresh water tank, and sufficient space for stores for an extended cruise. A stairway leads from the galley to the main deck. Next is the boiler-room, which extends to the engine-room bulkhead, and occupies 30 ft. 6 in. of the vessel's length. In this space are two boilers of the Mosher water-tube type, described in detail at a later point. Alongside the boilers are the coal bunkers, which extend nearly the entire length of the boiler space, and have a capacity of about 17 tons, while additional coal stowage space will provide for a total capacity of about 30 tons, or a sufficient amount to enable the vessel to cruise upwards of 3,000 miles. Aft of the boiler space is the engine-room, containing two of Mr. Mosher's quadruple expansion engines, in which are embodied a number of special features, referred to more particularly hereafter.

Immediately aft of the engine-room is the owner's stateroom, which occupies the full width of the ship, and is 7 ft. 6 in. long. This room will be handsomely fitted up, and will contain a large double berth, chiffonier, clothes press, wardrobe and private bath and toilet. The joiner work is of satin wood. It will be lighted by a monitor top and four large port lights, and at night by a number of incandescent lamps. Next aft, is the saloon, which is 13 ft. 6 in. long, and occupies the full width of the boat. It is to be the most luxuriously fitted up, and will contain a grand piano, library, an octagon buffet in each after corner and gun racks, etc., for a full sportsman's outfit. The saloon is arranged to be converted into four staterooms by hanging draperies, and is lighted by numerous clusters of incandescent lamps of variegated colors. These lamps are connected through an ingenious switch, by means of which any color of light may be had as desired. The joiner work is to be of English oak and the ceiling of Hungarian ash. The saloon is lighted by eight large port lights, besides being lighted and ventilated by a monitor top through which leads the companionway. Aft of the saloon is a double state-room, finished in Hungarian ash, and elaborately furnished, being fitted with two large berths, dress-case, large chiffonier, a wardrobe, folding wash basin, etc. This is lighted also by a monitor top, as well as by four large port lights. A toilet-room is arranged to open conveniently from both the saloon and state-room.

Aft of the state-room is the after-collision bulkhead, and aft of this is a fresh water tank holding 300 gals., and also a store-room of 300 ft. capacity. It will be noticed that the deck is particularly roomy, being clear of the usual houses. The pilot-house, the only deck-house carried, is 15

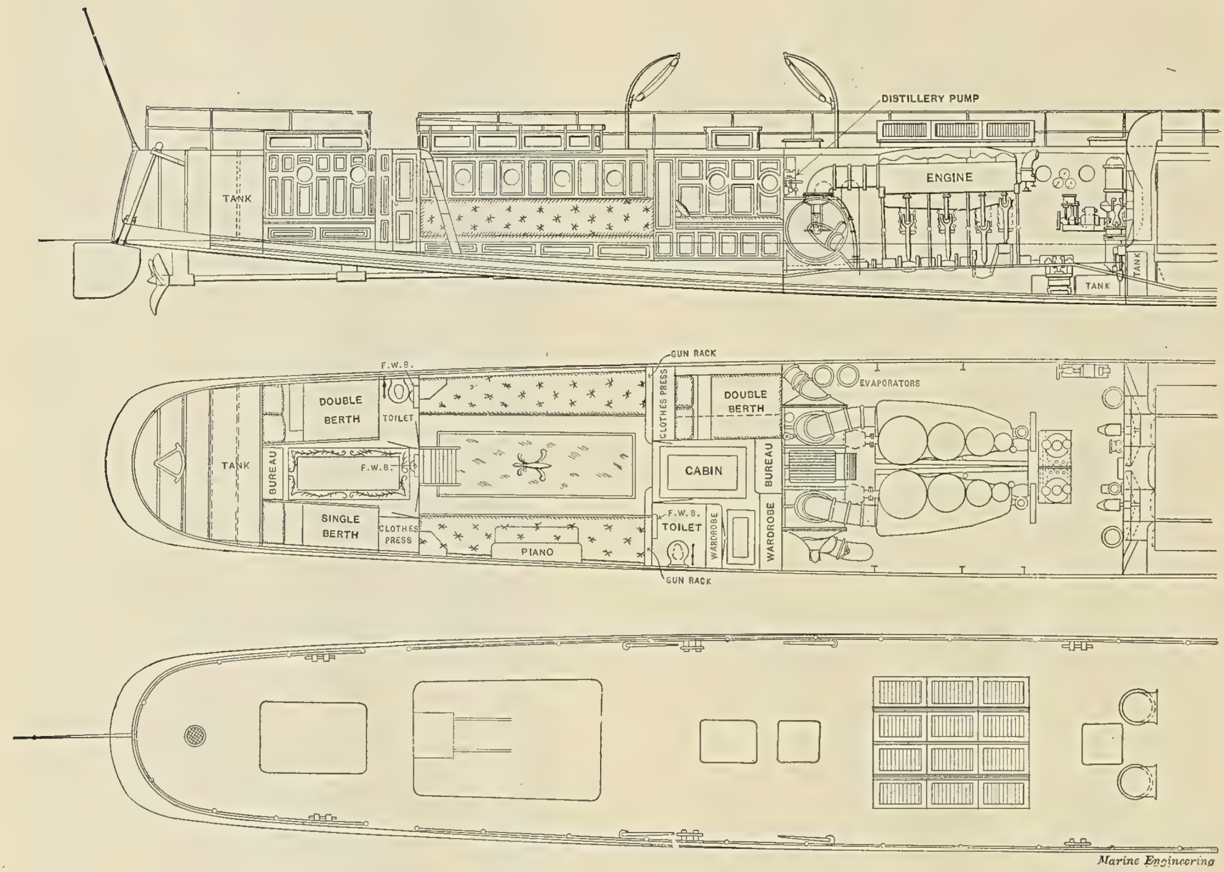


ARTIST'S SKETCH OF THE ARROW—57.66 TONS DISPLACEMENT, 4,000 I.H.P.—FITTED OUT AS A YACHT AND STEAMING FULL SPEED AHEAD AT SEA.

ft. long, and is arranged to be used as a dining-room. The after portion is divided off and arranged as a pantry, and is provided with silver and china closets, and is also fitted with a dumb waiter, which connects with the galley below. It is also connected with the store-room under the bridge. Aft of the pilot-house is the bridge 2 ft. 6 in. above the deck, and fitted with steering wheel, compass and binnacle, engine-room telegraphs, and a powerful searchlight, controlled both from the bridge and within the pilot-house. Under the bridge is located a spacious store-room.

The general construction of the boat is composite in character. The frames are steel below the water line and aluminum above, except through the boiler and engine spaces, where they are of steel throughout. The keelson, all floor plates, reverse frames, bunker bulkheads, boiler saddles, engine foundations, and many other details are also of steel. The sides are double-planked, with mahogany brought to a smooth, fair surface, and highly finished. The deck is of wood, except over the boiler space, where aluminum is used. The deck beams are of aluminum bulb angles. Aluminum is also used for many other details, such as side and deck stringers, hatch framing, hatch covers, breast hooks, etc. The outer keel, stem and stern posts, flooring, pilot-house, joiner work and other like features are of selected woods to best meet their respective purposes. Between the frames and sheathing on the sides and bottom, as well as between the deck plating and beams, a system of diagonal strappings is fitted, consisting of thin steel plates about 8 in. in width, tapering at the ends. This diagonal bracing or strapping is built in under tension, and is intended to give rigidity to the structure, as well as to tie the boat together longitudinally, and provide the necessary transverse and torsional strength and stiffness.

Two small boats will be carried—a 15 ft. cutter and a 13 ft. dinghey. The *Arrow* is to be fitted with an extensive electric plant, capable of supply sixty incandescent lights, and a powerful searchlight. Other auxiliaries include two powerful blowers for ventilation and supplying forced draft to the boilers, surface condensers, with circulating pump operated by engines of special design, bilge pumps, and six powerful ejectors, having a combined capacity of over 100 tons of water per hour.



INBOARD PROFILE, ACCOMMODATION AND DECK PLANS OF THE S. Y. ARROW.

Turning now to the boilers, we have the following principal items:

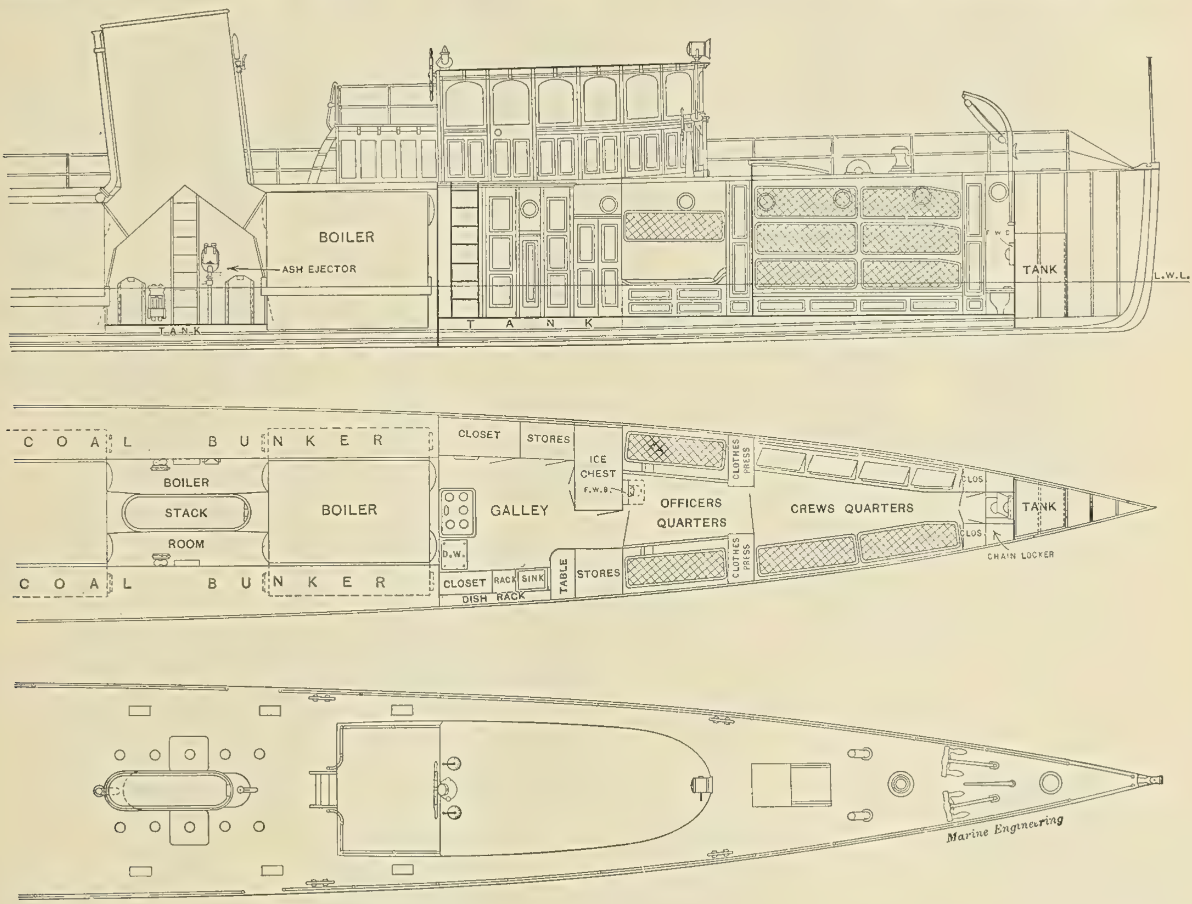
Type	Mosher patent curved water tube
Number	2
Grate surface	120 sq. ft.
Heating surface	5,540 sq. ft.
Pressure allowed by U. S. Steamboat Inspection	444 lb. per sq. in.
Weight of two boilers empty	12.86 tons
Weight of boilers in steaming condition	15.59 tons

Weight per sq ft. of heating surface without water	5.2 lb.
Weight per sq. ft. of heating surface with water	6.3 lb.

The usual full working pressure is intended to be about 400 lb. to 440 lb. at the boilers, and 350 lb. to 400 lb. at the engines.

There is one fire-room common to both boilers. In the boiler space are two specially designed blowers, two independent duplex feed pumps, two feed water regulators, and a hydraulic ash ejector, besides the usual gauges and fittings. There are two separate hatches for entering the boiler-room, each fitted with the entire thermal equivalent of the work expended during the expansion, thus keeping the steam in a superheated condition throughout its working cycle. The reheaters are intended to aid in the drying of the steam, and to effectually prevent cylinder condensation. The air and feed pumps are just forward of the main engine, and are geared directly to the main shafts.

An important and interesting feature of the design of these engines is the arrangement of the columns and diagonal braces constituting the supporting framework of the steam and valve cylinders. This arrangement is clearly shown in the accompanying drawing,



DESIGNED BY CHARLES D. MOSHER FOR CHARLES FLINT, OF NEW YORK.

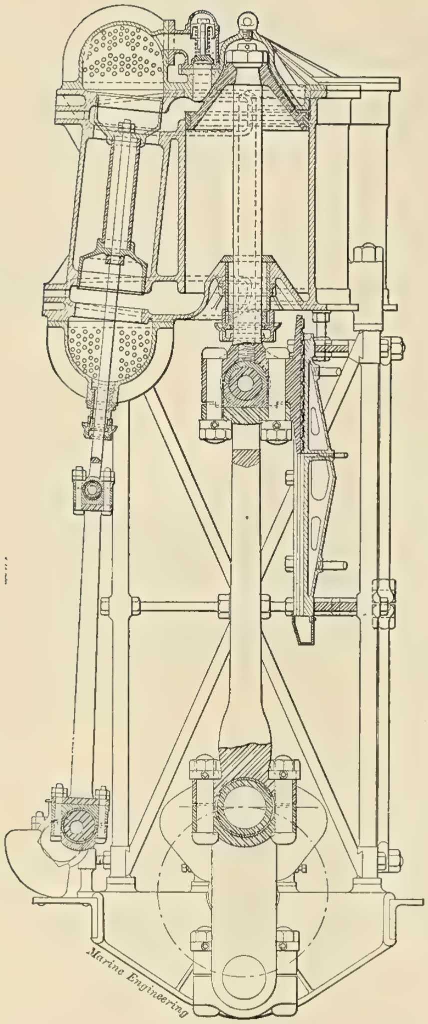
a large port light. The fire-room is lighted by four large deck lights.

Passing now to the propelling engines, we have the following chief particulars:

Type	Mosher patent quadruple expansion
Number	2
Diams. of cylinders	11 in., 17 in., 24 in., 32 in.
Stroke	15 in.
Working pressure at cylinders	350 to 400 lb.
Revolutions per m.	540 to 600.
Piston speed	1,500 ft.

Calculated power developed under 540 revolutions and 350 lb., at the engine about 4,000 I. H. P.

Both engines exhaust into one condenser, which has a cooling surface of 2,760 sq. ft. Between the steam cylinders of the engines a series of reheaters is installed, each one of which is capable of supplying and is designed to eliminate the danger of crystallization and fracture, due to rapidly alternating compressive and tensile strains, to which the framing of extreme high speed and high-powered engines of this class is commonly subjected. It will be observed that the diagonal braces are secured together in pairs at their centers by means of a bolt and nuts, by the adjustment of which the supporting columns can be subjected to a compressive, and the diagonal braces to a tensile strain, which is intended to be in excess of any normal working strains that may come upon them. By this arrangement, it is obvious that the supporting columns will at all times be practically subjected to compressive strains only, varying in intensity as the working strains of the engine increase or relieve the initial stress due to the tension of the

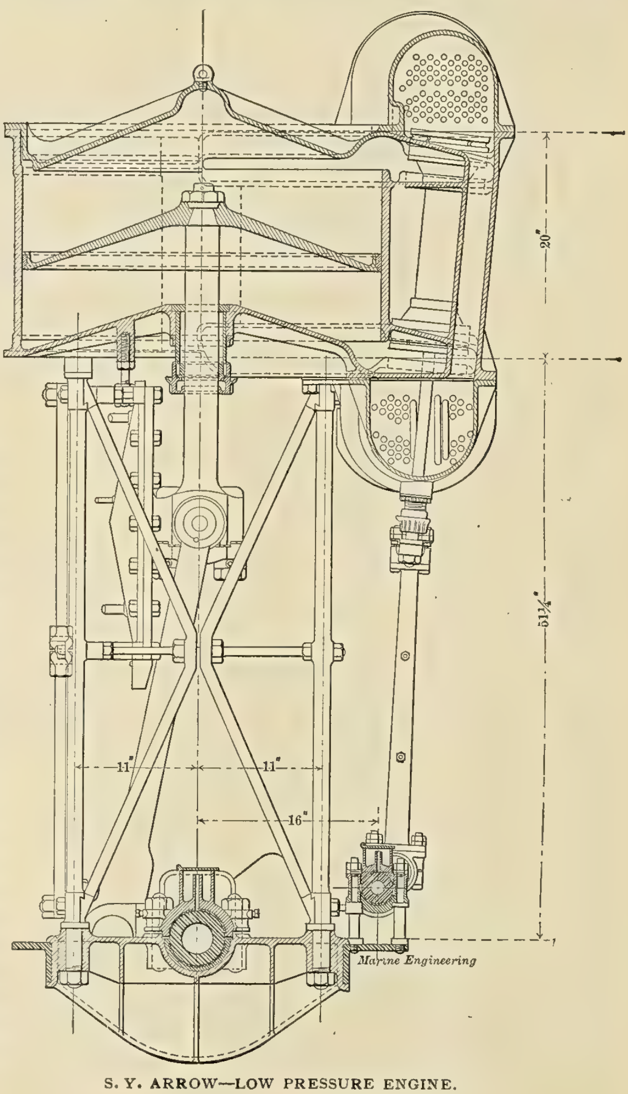


S. Y. ARROW—HIGH PRESSURE ENGINE.

diagonal braces. These braces are in turn subjected to tensile strain only, of varying intensity, but constant to the extent of taking up and absorbing practically all the initial elasticity of the structure. A remarkably rigid construction is thus attained, assuring a perfect alignment of the engine at all times, and greatly eliminating vibration, since the initial or starting movement, without which there can be no vibration, is effectually prevented.

The feed water, before returning to the boilers, is heated in a pair of Mosher patent four-stage or compound feed water heaters, which are placed near the boiler-room bulkhead. This style of heater is formed of a cylindrical shell, with hemispherical ends, and a series of transverse partitions dividing the internal space into four compartments. The compartment at one end is provided with a connection for the feed inlet, and that at the other end with a like connection for the outlet. Series of tubes pass through the several partitions, and connect the two end compartments to each other, thereby forming a continuous conduit for the feed water, which thus transverses the several compartments in series. The spaces surrounding the tubes in the compartments constitute independent chambers, separated by the partitions, and thus adapted to receive steam of different pressures for supplying the heat required. The first chamber is connected with the main exhaust pipe from the L. P. cylinder, and the feed is first heated from this source. It then passes on into the second chamber, the steam side of which is supplied from the L. P. steam-chest, or third receiver. In like manner the third chamber is supplied with steam from the second intermediate steam-chest, or second receiver, and the fourth and last chamber from the first intermediate steam-chest, or first receiver.

In this manner the feed water is successively heated by a series of transfers of heat from the expanding or working part of the steam cycle, at a series of increasing temperatures until it is finally delivered to the boiler at a temperature calculated to be about 350 degrees. It is only recently that the full thermodynamic significance of this operation has been realized. Examination shows, however, that such a series of heat transfers aid directly in bettering the efficiency of the engine, by reason of the modification which is thus introduced into the steam cycle, such modification having the effect of carrying the working cycle nearer to the ideal than it otherwise would be. The



S. Y. ARROW—LOW PRESSURE ENGINE.

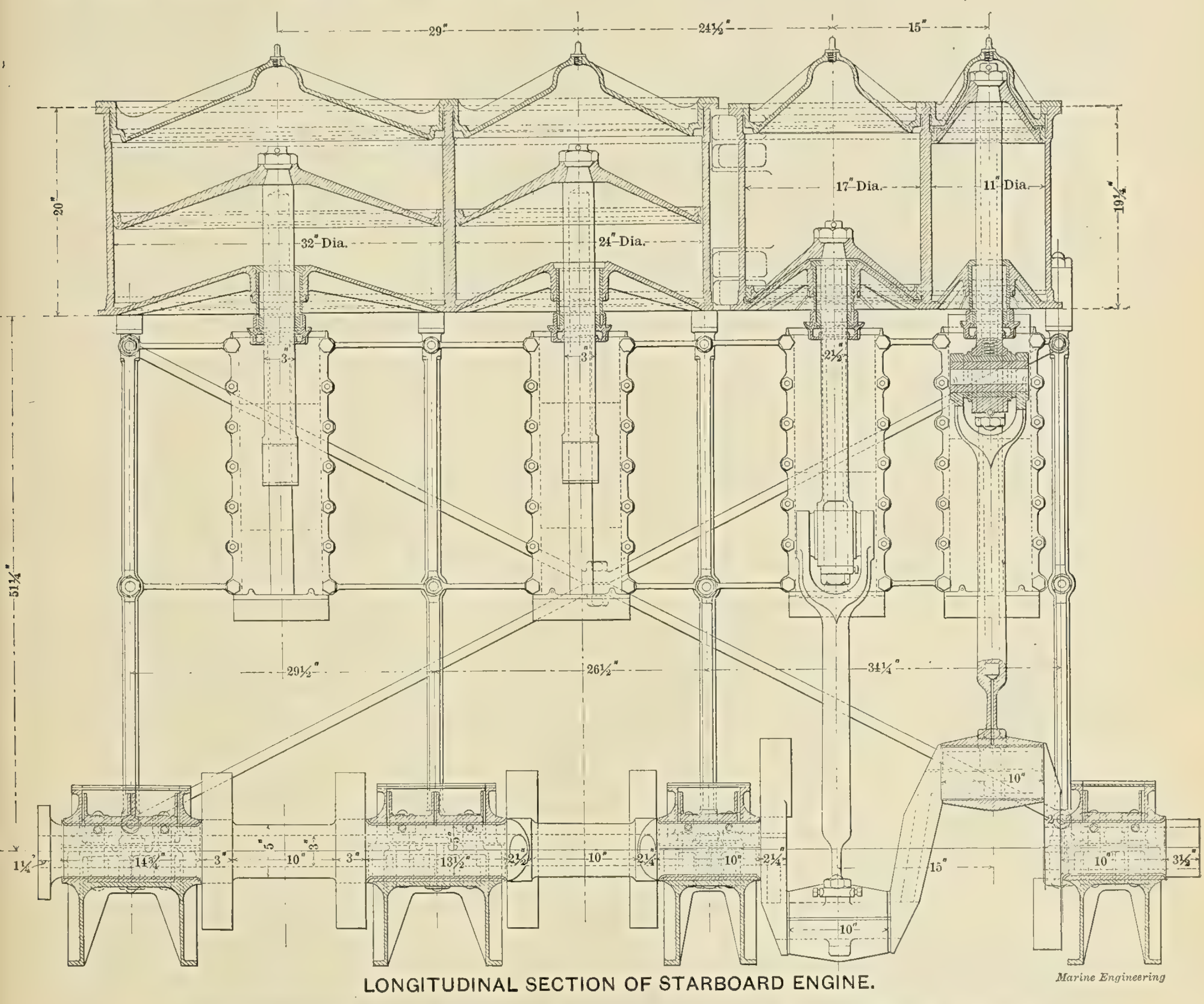
result is, therefore, a closer realization of the conditions for the cycle of the ideal engine, and hence a correspondingly higher efficiency.

In order to carry this operation to the fullest extent and thus to realize substantially the full ideal efficiency, it would be necessary to take the feed water and raise it by an indefinitely large number of very small steps from the lower temperature to that of the boiler, drawing the steam for each step from the point in the expansion stage of the engine having a temperature only slightly greater than that of the water itself. In this way each increment of heat would be given up from

As already stated, the power which is expected from the engines of the *Arrow*, working under the conditions mentioned, with 350 lb. of steam, is about 4,000 I. H. P. The following relations will be of interest in this connection:

I. H. P. per sq. ft. of grate surface	33.
Heating surface per I. H. P. at 4,000 H. P.	1.39
Pounds total machinery, including water, per I.H.P.	17.78

In connection with the designed power, the points which will make for high economy, and hence for a



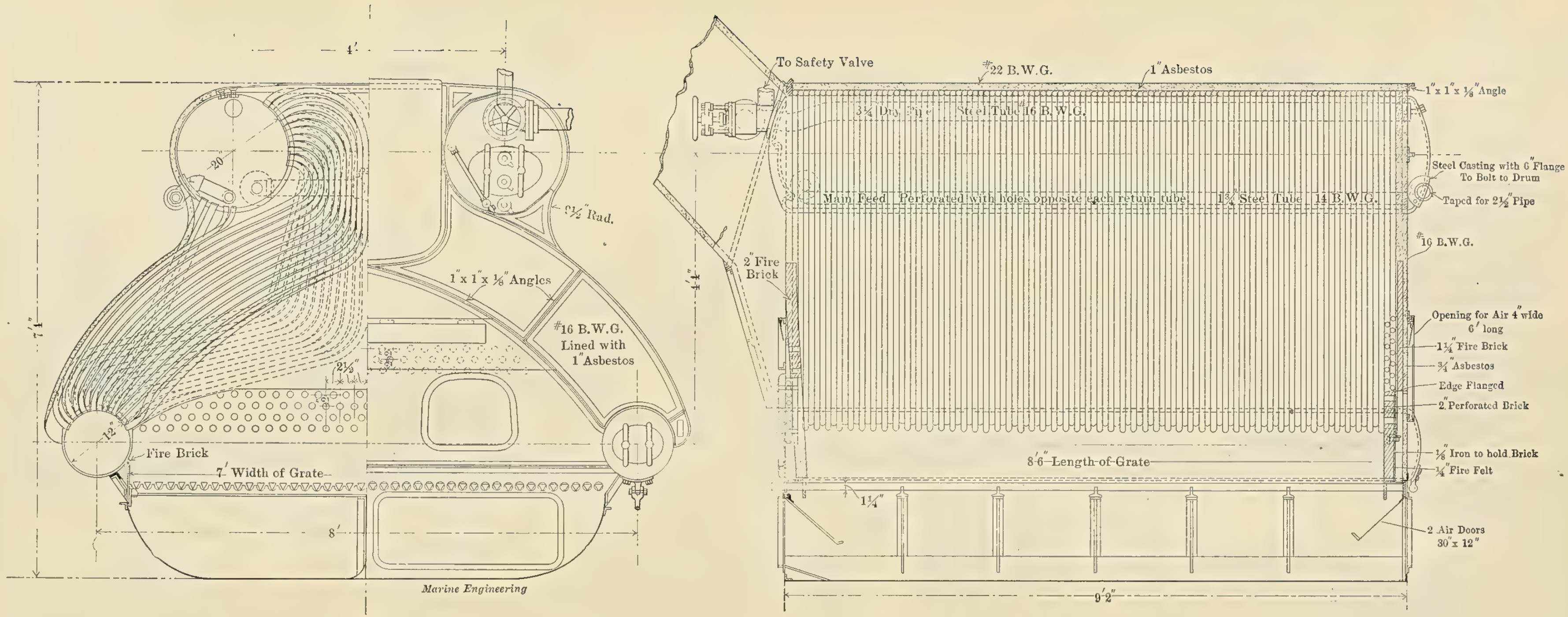
LONGITUDINAL SECTION OF STARBOARD ENGINE.

WORKING DRAWING OF THE QUADRUPLE EXPANSION MOSHER TYPE ENGINES OF THE S. Y. ARROW.

the steam and received by the water at very nearly the same temperature, and by such a series of operations the water would be raised to the temperature in the boiler. Such would very nearly fulfill the conditions for the heating of the water, requisite to realize the highest efficiency so far as this part of the cycle is concerned; and it is readily seen that the four-stage heater, as here described, makes a close approximation to the practical fulfillment of these conditions.

large return per pound of boiler and per pound of coal may be briefly summarized at this point:

The initial pressure is far beyond that which is found in current practice, even with torpedo boats and other high speed craft. The increase is from 100 lb. to 150 lb. This pressure corresponds to an elevation of the initial temperature of about 30 deg., and this would correspond to a gain of about 7 per cent. in the ideal efficiency as compared with that for say 250 lb. pressure, while if the pressure was increased 150



SCALE DRAWING OF THE MOSHER CURVED TUBE WATER TUBE BOILERS OF THE S. Y. ARROW, BUILT FOR A WORKING PRESSURE OF 400+LB. PER SQ. IN.

lb. or 400 lb. at the engine, corresponding to a rise of about 44 deg., it would in the ideal engine correspond to a gain of nearly 11 per cent., as compared with the usual practice of 250 lb. We may next note the very considerable wire drawing from the boiler to the engine, which will tend to dry and superheat the steam and thus to aid in reducing the wastes due to internal condensation. The action of the reheaters will also serve in the same line to keep the steam dry, or even superheated, as it passes through the successive cylinders of the engine. The total number of expansions will be about 15.67, and they are carried out in a quadruple, or four-stage, expansion engine with the corresponding gains which may be justly expected when using steam of such high pressure as is here employed. To these various features we must add the action of the four-stage feed water heater as described.

Then in the engine itself the cylinder clearances have been by careful design reduced to a very low value, a feature directly favorable to high efficiency of operation. Considering these various features, which will bear on the question of the economy of the engine, it seems not too much to expect an exceedingly economical development of power. It would be, of course, unsafe to predict a water rate, but it certainly would not be surprising if it should fall to the vicinity of 10 lb. per I. H. P. per hour.

A further question of the greatest interest is in regard to the speed which may be expected. Here again predictions are unsafe on account of no precedent approaching the great increase of power per unit of displacement, but considering that the form of the boat has been especially designed for the attainment of the highest possible speeds, involving a large amount of model experiment carried out by Mr. Mosher, and assuming that 4,000 I. H. P. and probably more are developed on a mean displacement of 60 tons or somewhat less for a speed run, a speed of something over 40 knots, or 46.25 statute miles per hour, is within the possibilities—a rate in excess of anything hitherto accomplished.

In the engine room, in addition to the two sets of quadruple expansion engines for propelling the boat, each of which is fitted with a steam reversing engine, there are two engines for driving the blowers for supplying ventilation and forced draft, an electric light engine and dynamo, two circulating engines for pumping the injection water for the condenser, duplex bilge and fire pumps, and auxiliary air pump for supplying a vacuum when the air pumps attached to the main engines are not running, a distilling pump, and two evaporators and distillers of sufficient capacity to supply fresh water for the entire boat service. In addition to these are the steam steering engines and auxiliary feed pumps for the boiler-room, two feed water heaters and condensers.

The hull has been constructed at the shipyard of Samuel Ayers & Son, of Nyack, N. Y., who also built the *Ellide* and other fast boats from Mr. Mosher's designs. It is all ready to receive its machinery, and will probably be launched before this reaches our readers. The boilers are nearing completion at the Crescent Shipyard, Elizabethport, N. J. The main engines and all auxiliaries have been constructed by the L. Wright Machine Works, Newark, N. J.

The boat and machinery have been designed in every part and detail by Mr. Mosher, and it is expected that the performance of the *Arrow* will surpass his past achievements in the design of high-speed boats.

On a recent westbound voyage, the White Star S.S. *Oceanic* touched bottom off the Irish coast during a dense fog. No serious damage was done, and the vessel proceeded up the Channel to Liverpool.

While trying to come alongside a wharf at Newport, R. I., the torpedo boats *Dahlgren* and *Craven* came together, October 16, and both vessels were badly damaged, but remained afloat. There was a heavy wind and sea at the time.

While the new French liner *La Lorraine* was crossing the Atlantic on the night of October 7, a fracture occurred in the forked end of the low pressure connecting rod of the port engine. The vessel proceeded with starboard engine only working, and the engineer's staff substituted a spare for the broken rod. There was a very heavy sea on at the time, and as the vessel rolled heavily, the work of repairs was necessarily slow, but after about fifty hours' hard work, the port engine was ready for business again. The remainder of the voyage to New York was accomplished without incident.

In a collision off Nantucket shoal, October 1, the Lamport & Holt S.S. *Biela*, 2,182 tons, was sunk by the British freighter *Eagle Point* bound from London to New York. The collision occurred about 1 o'clock in the morning, when most of those on the *Biela* were below asleep. They were awakened by the shock of the collision, and promptly got on deck, when the boats were lowered and all transferred to the *Eagle Point*, which was kept afloat by her forward compartment. The *Eagle Point* hit the *Biela* bows on about amidships, almost cutting her in two. The *Biela* was an old iron vessel, built on the east coast of England thirty years ago.

SIX CYLINDER TRIPLE EXPANSION ENGINES OF CHILIAN CORVETTE GENERAL BAQUEDANO.*

BY MAGNUS SANDISON.

The corvette *General Baquedano* is a training or school ship of 2,500 tons displacement. She was built by Sir W. G. Armstrong, Whitworth & Co., Ltd., to the order of the Chilian Government, and her machinery was constructed by Hawthorn, Leslie & Co., Ltd.

It was desirable that this vessel should be able to steam very economically at low speeds, and it was decided to adopt a six-cylinder engine, which I had suggested some time previously.

The steam trials of the vessel have recently been completed, and I am enabled, through the courtesy of Rear Admiral Castillo, the President of the Chilian Naval Commission in Europe, and by the permission of my firm, to lay before the Institution a brief description of her propelling engines.

The design possesses some novel features, and the arrangement forms a combination which solves with a considerable measure of success, in a simple manner, and at one and the same time, some important problems which have of recent years engaged the attention of those interested in the design and manufacture of the propelling machinery for vessels of war.

Briefly these are as follows:

(*a*) The production of an engine which will work with economy when developing a small proportion of its full power, and thus ensure in a given ship the maximum radius of action.

(*b*) The elimination, as far as possible, of the unbalanced forces in the engine.

(*c*) The securing, as far as possible, of uniformity in the turning effort on the crank shaft.

(*d*) The reduction to a minimum of the chance of total disablement.

The machinery consists of a single screw engine driving a feathering propeller, steam being supplied by four Belleville boilers, having a steam pressure of 300 lb. per sq. in. reduced to 250 lb. at the engine.

The engraving (page 457) illustrates generally the arrangement of the engine. It will be observed that, carried upon one bed-plate, there are two high-pressure, two intermediate, and two low-pressure cylinders, acting on six cranks. The high-pressure cranks are opposite and adjacent to one another, the intermediate cranks are also opposite and adjacent to one another, and 240 deg. in advance of the high-pressure cranks; while the low-pressure cranks, also opposite and adjacent, are 240 deg. in advance of the intermediate cranks.

Each high-pressure cylinder is provided with its steam stop valve. The forward high-pressure cylinder exhausts into the forward intermediate-pressure cylinder, which in its turn, exhausts into the forward low-pressure cylinder; the after high-pressure cylinder exhausts into the after intermediate pressure cylinder, which, in its turn, exhausts into the after low-pressure cylinder. Each low-pressure cylinder exhausts into its own condenser, this being provided with its own air and circulating pumps, the former being worked by levers from

* A paper read before the Institution of Naval Architects London.

the corresponding low-pressure engine, and the latter being the ordinary centrifugal type.

There are thus acting upon the crank shaft virtually two independent three-cylinder triple-expansion engines of equal size, the cranks of which are alternated with one another.

We will consider shortly some of the leading features in the arrangement.

It is unnecessary to remind members of the uneconomical performance of an engine when doing a small proportion only of the full work which it is designed to perform, or of the extravagant cost of the last knot, or two, in our fast cruisers, or of the comparatively rare occasions upon which such vessels are called upon to exert their full power.

This problem of economical propulsion at low powers has been dealt with on various occasions and in various ways. In H. M. S. *Alexandra*, built in 1875, small auxiliary condensing engines were fitted to turn the main shafts by means of gearing when the ship was under sail.

Sir John Durston, in an interesting paper entitled "Some Notes on the History, Progress and Recent Practice in Marine Engineering," read before the Institution in 1891, makes reference to various arrangements of propelling engines which have been fitted more recently in the Royal Navy, with a view to economy at low powers.

In the *General Baquedano* it will be seen that, by disconnecting and securing the bottom ends of the connecting and valve rods of one set of engines, the other set can still drive the propeller, and do so with an economy equal to that which is attained in the best Mercantile Marine practice, the cylinders being proportioned with this object in view.

The speed trials of this vessel consisted of: (1) a six hours' run at full power, and (2) a thirty hours' run at three-fifths full power. On the full power trial she steamed 13.75 knots per hour with a mean of 154 revolutions per minute.

At the conclusion of this trial the turning gear was shipped, and within an hour from that time the vessel was under weigh again, steaming with one set of cylinders only, the bottom ends of the disconnected rods being secured by means provided for the purpose.

Comparative trials of the vessel, at the same speed, under the two conditions of working, viz., with three cylinders and six cylinders respectively in operation, were not made, as the time at our disposal was limited. These were postponed until some convenient occasion after the commissioning of the vessel, and I regret I am therefore unable to place the results before the Institution.

It may be noted in passing that, in the case of the vessel under consideration, which is fitted with a feathering screw, it is possible, by reducing the pitch, to develop half power with one set of cylinders only working; but in vessels fitted with ordinary screws, and with two engines on one shaft, the proportion of power which can be developed under this condition is of necessity less.

I am not aware of any published results of trials carried out in such vessels, with the view of determining the relative economy under the two conditions; but it would appear to be a direction in which experiments might with advantage be made.

This corvette is, it will be observed, of comparatively low speed. A cruiser whose maximum speed is, say, 23 knots, would probably steam about 19 knots with half the cylinders in operation, a speed which is as high as, or probably a great deal higher than, would be demanded from her under ordinary circumstances.

I do not, of course, suggest that with this arrangement the operation of connecting or disconnecting is one nominally of a few seconds' duration, such as would be theoretically obtained by the introduction of a disconnecting coupling between the crank shafts of two engines, one being placed forward of the other; or by driving back a set of shaft coupling bolts, both of which are usually delicate and may be vexatious operations, but it is one which forms a rudimentary part of the education of the engine-room artificer or seagoing engineer.

It should be noted in this connection, that, with the engines interlaced, as it were, the continuity and rigidity of the crank shaft are maintained under all conditions of working, and that the main bearings being always in operation, whether one, or other, or both engines be used, this shaft cannot wear out of truth as would be the case were one engine placed forward of the other on the shaft, and these bearings are always maintained in line and in working order.

It is obvious that, should it not be desired to disconnect one engine, but to have all the cranks available for instant service, steam may still conveniently be passed through either engine sufficient to merely lubricate the internal rubbing surfaces, and in no case would it be desirable to have one set of engines uncoupled under the service conditions which prevailed, for example, during the battle of Santiago, and which were alluded to by Rear-Admiral Melville of the United States Navy, in his paper dealing with Triple Screw Propulsion, read last year before this Institution by my friend Lieut. Norton, U.S.N.

As regards the balance of the arrangement, Diagram I shows, for purposes of comparison, the forces tending to produce vibration in three types of engines, the designs of which were prepared for a twin-screw cruiser of 30,000 I.H.P., the engines in each case running at 120 rev. per min. (See page 458.)

Fig. 1 is for a six-crank engine similar to that described in the paper, with the six cranks in operation, the cylinders being two of 31 in. dia., two of 50 in. dia., and two of 81 1-2 in. dia., by 48 in. stroke.

Fig. 2 is a four-cylinder engine balanced on the Yarrow, Schlick, and Tweedy system, the cylinders being 43 1-2 in. dia., 71 in. dia., and two of 81 1-2 in. dia., by 48 in. stroke.

Fig. 3 is for a four-cylinder engine of the ordinary type, the cylinders being of the same dimensions as in the preceding case.

The curves for the six-crank engine compare very favorably with those of the four-crank engines.

With regard to the conditions which prevail when one set of engines only is working, it may be remarked that, under these circumstances, not only are the reciprocating weights very much smaller than would be the case were one engine capable of developing the full power used to develop the low power, but the

cranks of the disconnected engine act in some measure as balance weights for the working engine.

A similar comparison of the twisting moments on the crank shaft for the same engines is given on Diagram II, and shows at a glance the very marked superiority of the six-crank design in this respect. In Fig. 1, *i.e.*, the six-crank design, the loads on the crank pins are equal. In Figs. 2 and 3, the loads on the low-pressure pins are half those on the high-pressure and intermediate-pressure pins, being the proportion frequently adopted in this type of engine.

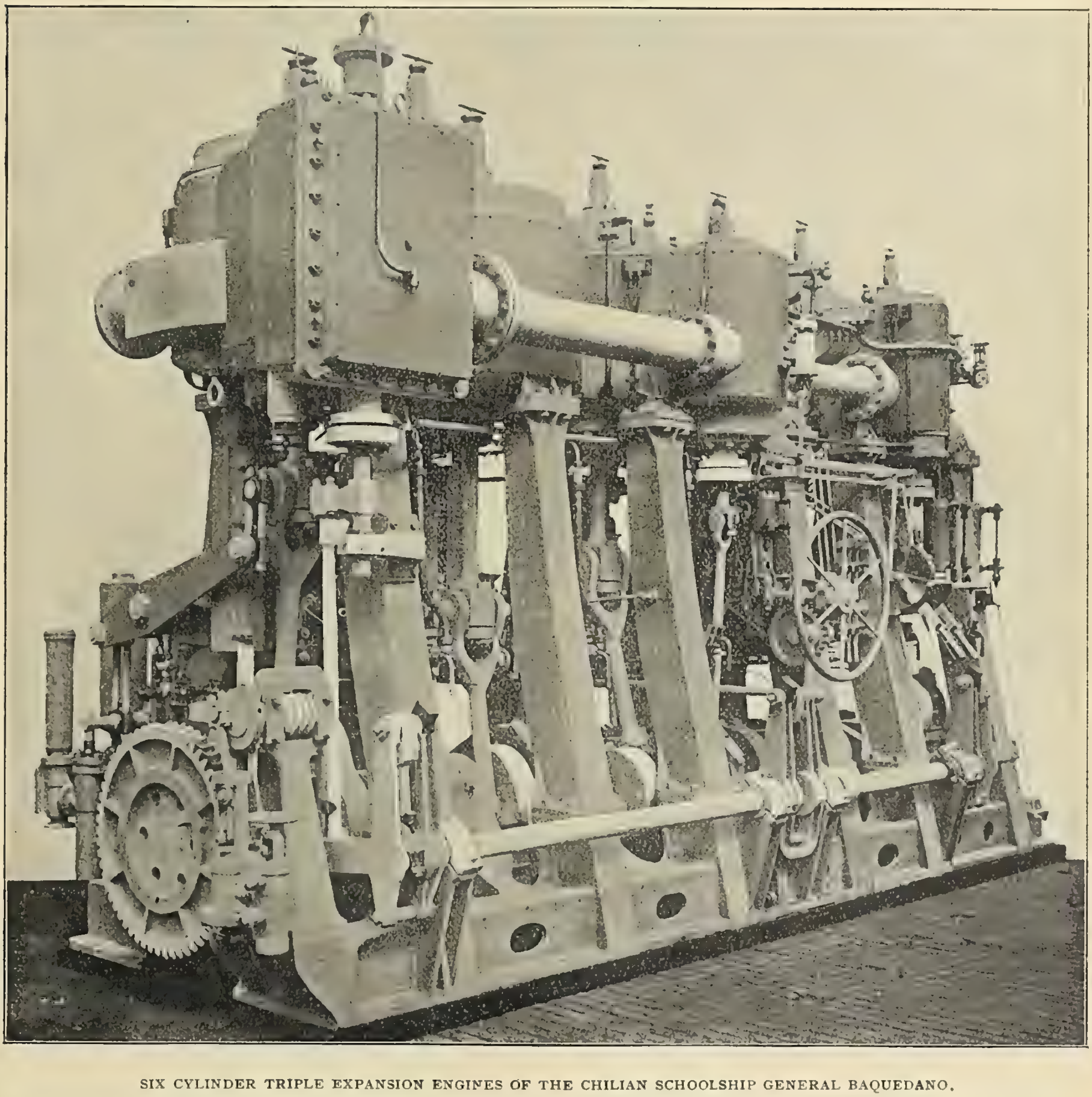
The following table gives the total weight of the engines, the weight added to produce the balance shown in the diagram, and the length of engine-room in the three types of engines. (Table in next col.)

The length of the engine-room is the same in each case; but we ought not to overlook the fact that, had link motion been adopted for working the valves, the length of the engine-room in the six-crank design would have been greater than that given in the table, unless, indeed, certain of the valves had been arranged at the back or front of the engine, and operated by means of levers in the manner which has frequently been employed both in the Navy and Merchant Service.

Design.	Total Weight in Engine-Room in Tons.	Added Weight in Lbs.	Length of Engine-Room. ft.	in.
Six crank	1,010	5,600	67	6
Yarrow, Schlick and Tweedy.	975	9,826	67	6
Ordinary four-crank	975	8,800	67	6

The type of valve gear adopted lends itself very readily to the arrangement, the weigh shafts, one on each side of the engine, being connected by a link, and worked by one reversing engine.

In order to counteract any possible tendency to set



SIX CYLINDER TRIPLE EXPANSION ENGINES OF THE CHILIAN SCHOOLSHIP GENERAL BAQUEDANO.

fast on the part of the disconnected gear, if disconnected for a lengthened period, the securing gear is so arranged as to permit of a limited motion being given to the various parts.

The handling of the engines, whether three or six cylinders are at work, is performed with the same ease as in the case of any ordinary triple-expansion three-cylinder engine, one or both engines being worked by the same regulator and reversing engine. It has been previously stated than an independent steam shut-off valve is attached directly to each high-pressure cylinder.

In an arrangement of this nature, the piston rods,

CURVES CONSTRUCTED FOR 120 REVOLUTIONS PER MINUTE

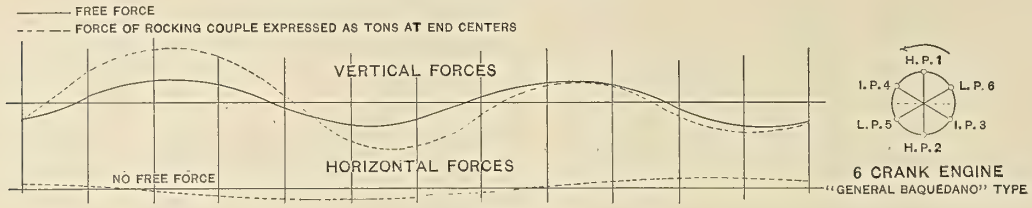


FIG. 1.

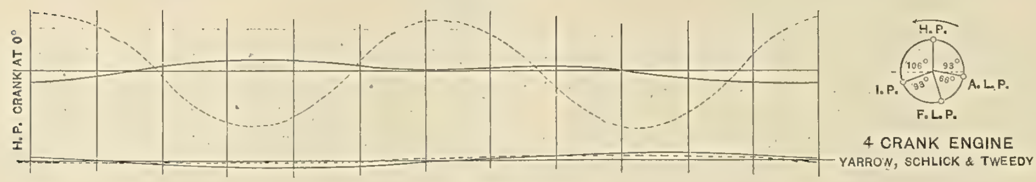


FIG. 2.

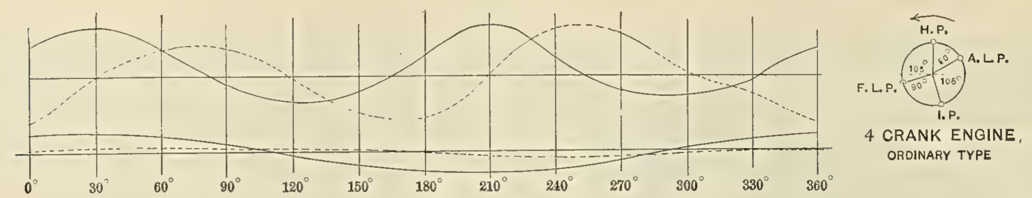
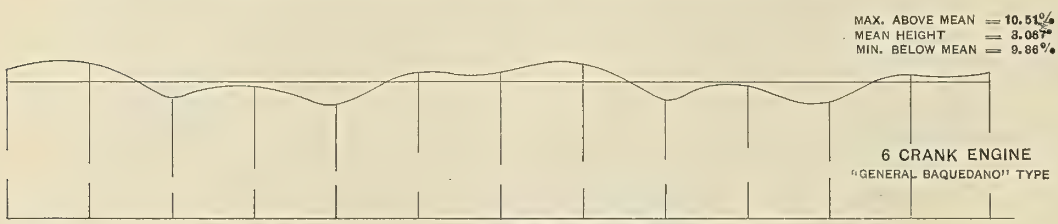


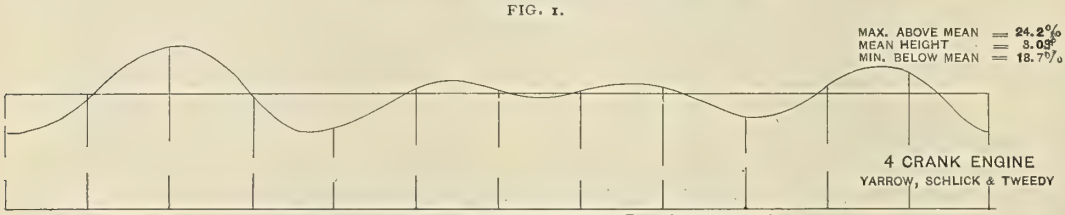
FIG. 3.

DIAGRAM I.—COMPARATIVE CURVES OF VIBRATION FORCES FOR TWIN-SCREW CRUISER OF 30,000 I. H. P.



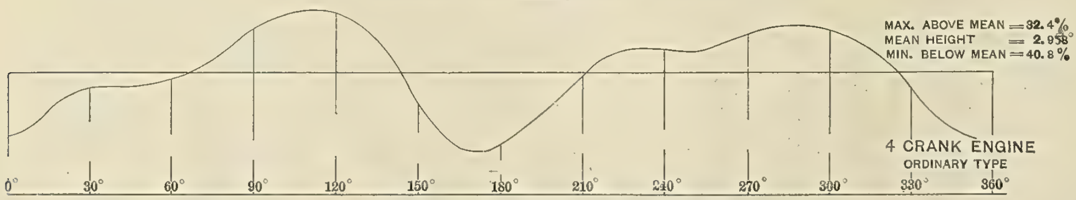
MEAN TWISTING MOMENT = 3681 INCH TONS
MEAN TANGENITAL EFFORT ON CRANK PIN = 153.37 TONS

FIG. 1.



MEAN TWISTING MOMENT = 3624 INCH TONS
MEAN TANGENITAL EFFORT ON CRANK PIN = 151 TONS

FIG. 2.



MEAN TWISTING MOMENT = 3549 INCH TONS
MEAN TANGENITAL EFFORT ON CRANK PIN = 147.8 TONS

FIG. 3.

DIAGRAM II.—COMPARATIVE CURVES OF TWISTING MOMENTS OF TWIN-SCREW CRUISER OF 30,000 I. H. P.

connecting rods, &c., and their accessories are duplicates throughout, unless the two engines are designed to develop different powers when working together.

It is advantageous, although not essential, to have a separate condenser and air pump for each low-pressure cylinder; not only is the independence of each engine thereby more fully maintained, but a greater command over the temperature of the feed water is secured. As a matter of fact, in the *General Baquedano* valves were provided at the request of the Chilian Commission, which enabled each condenser and air pump to be used for either engine.

Alternative arrangements of cylinders are obvious. Fig. 1, Diagram III, shows in outline the cylinder tops in the case of the *General Baquedano*, Fig. 2 shows another arrangement, and Fig. 3 still another. The latter is the arrangement adopted in the case of twin-screw engines of 16,500 I.H.P. for the Russian Volunteer Fleet. Messrs. Hawthorn are at present engaged in constructing these engines, and we have others in contemplation.

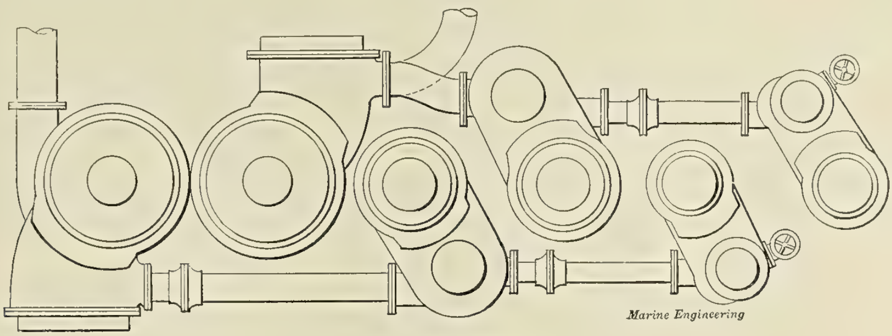


DIAGRAM III.—FIG. 1.

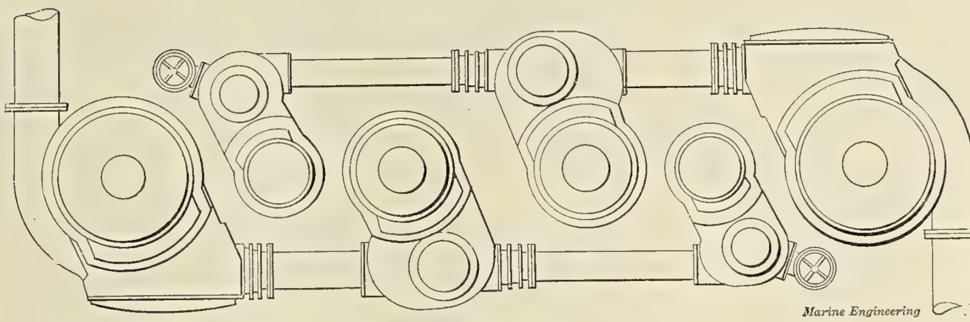


DIAGRAM III.—FIG. 2.

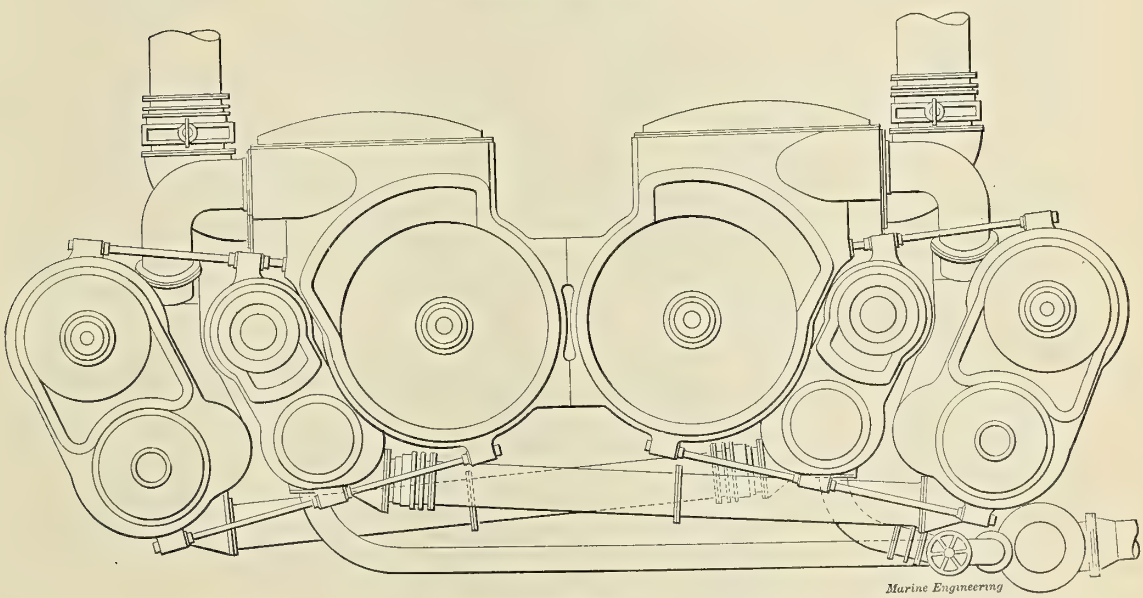


DIAGRAM III.—FIG. 3.

It is manifest that quadruple-expansion engines may be dealt with in a similar manner to that described in this paper, thus forming eight-crank engines.

My firm has recently, with a view to economy, proceeded on somewhat similar lines in connection with

the steering arrangements of some of our large cruisers. These are fitted with two steering engines; but, instead of making these engines duplicates, we have provided different sizes, a large engine for use when the vessel is steaming at the higher speeds, and a small engine of only sufficient size to do the work when the vessel is cruising or steaming with a limited boiler power.

I have endeavored in the foregoing remarks neither to magnify the advantages nor to minimize the disadvantages of the arrangement described.

American Liner Philadelphia.

We present herewith three original photographs of the American liner *Philadelphia*, originally the *City of Paris* of the Inman line, and in more recent times the *Paris* of the American line. These views show in part the present condition of this fine ship, which, it will be recalled, is in dry dock at Belfast, Ireland, undergoing reconstruction after her experiences ashore on the Manacle Rocks off the coast of Cornwall in the English Channel.

It is doubtful if at any previous time any vessel even approaching the size of the *Philadelphia* underwent such a complete overhauling. There have been cases in which practically a new bottom has been worked into a vessel that has had the misfortune to have gone ashore—notably in the case of the P. & O. liner *China*. In this instance, however, not only will the hull below water be largely renewed, but the old machinery will be replaced entirely by engines and boilers of more modern design, and the passenger accommodations will be entirely changed in many important essentials. When the *Philadelphia* resumes her trips in the New York-Southampton trade, she will be a faster and more comfortable ship than the old *Paris*.

Up to the present time the work done on the vessel has been chiefly in the direction of clearing away the damaged and discarded in preparation for the new work. Following the experience gained with the S.S. *Milwaukee* and other vessels, high explosives have been used almost exclusively in removing the plates and structural members which are to be replaced. In this way tons of material have been cut out in mass very expeditiously. While this work has been going on the vessel has been stripped of all her cabin, deck, and engine and boiler room fittings. As the photographs show, the three funnels are gone, and so are the boilers and engines, their substance having been added to the scrap pile some time ago. The photographs do not show the extent of damage which the vessel sustained, as, owing to practical limitations, it was found impossible to get other views. Looking at the vessel from the dock coping, the extent of the injuries are not apparent, and even below the after part of the bottom is not very seriously damaged. Forward of amidships, however, the present condition of the ship is very unusual. The entire bottom has been blown out from side to side, and the interior for a space fore and aft exceeding the beam of the vessel has been gutted, leaving only the deck beams in place, and giving the interior the appearance of an enormous cavern. It was at this point that the vessel suffered most by contact with the rock-bound Cornish coast.

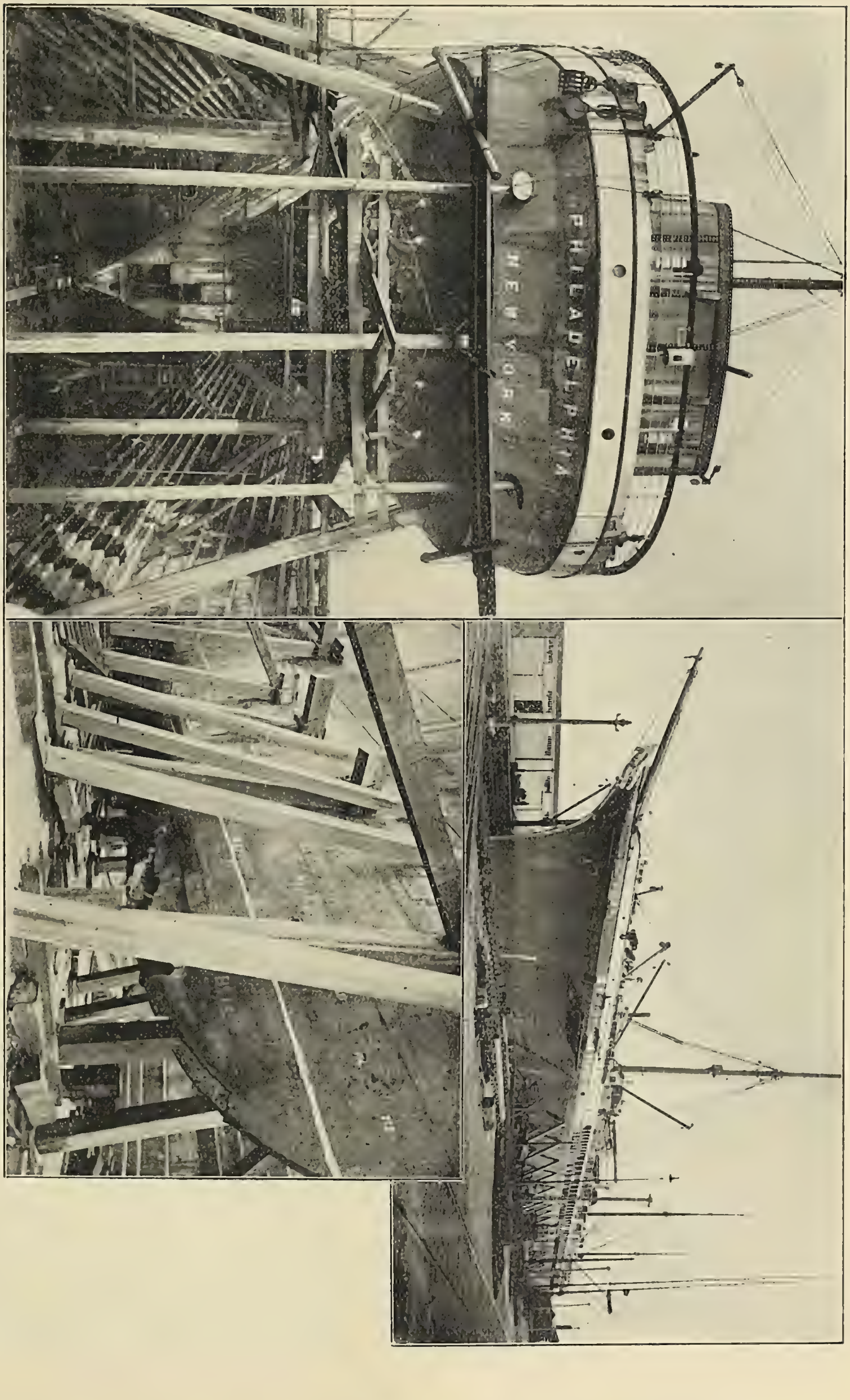
When ready for sea again, the *Philadelphia* will differ from the *Paris* and her sister, the *New York*, in general appearance, in that she will have two funnels instead of the familiar three. Inboard, however, there will be many changes. The inconvenient arrangement of promenade deck on both the *Paris* and *New York* by which the large ventilators block the fore and aft passage way when the passengers' deck chairs are extended, we understand, is to be rearranged, giving a clear, unbroken deck. Changes in construction will also permit of movement in a fore and aft direction on each deck in the cabin passengers' department, without the necessity of going out of doors. Other minor improvements will be made, especially in the arrangement and equipment of the saloon suites of rooms.

In the engineers' department the changes will be greatest. New engines, of the quadruple expansion type, to drive the twin screws, are now under construction in the shops of Harland & Wolff, the contractors for the reconstruction of the liner. These will have cylinders 38 1-2 in., 76 in. and 106 in. dia. and 60 in. stroke. Boilers of the Scotch type will be installed, six double-ended 19 ft. 6 in. long and four single-ended 10 ft. 6 in. long, all of 15 ft. 8 in. dia.

In the hull construction, the only change of importance will be the encasing of the propeller shafts within the hull in the usual Belfast style, instead of carrying the shafts outboard with struts, as on the *Paris* and *New York*.

In carrying out the work, the contractors have a free hand. and it is their intention to give back to the owners a ship which will clip the record of the *Paris* in her best days.

TRANSPORT HARDINGE.—Of late the famous Fairfield yard at Govan on the Clyde has been engaged almost exclusively on naval work. An interesting vessel, however, of the merchant type recently launched at the yard is the troopship *Hardinge* for the government of British India. The dimensions of this vessel are: Length 423 ft. 6 in.; beam 50 ft.; depth to main deck 31 ft.; gross tonnage 5,600 tons. She will be fitted with twin screws, with triple expansion engines having cylinders 29 in., 46 in. and 72 in. dia. and 48 in. stroke. There will be five Scotch boilers constructed for a working pressure of 180 lb. per sq. in. Howden draft will be fitted. There will be accommodations on this transport for about 1,500 persons. The vessel is of the spar deck type and has four complete laid decks; orlop, troop, main and spar deck. This last deck is made with an extensive promenade space, giving room for exercising soldiers. Very special care has been taken in the matter of subdivisions, which, both in the double bottom and hull proper, are numerous and watertight. Ventilation has also been well considered and a variety of fans installed. There is also an extensive refrigerating plant for supplying cool water and ice and for preserving the food supplies while the vessel is in the tropics. Structural details have been introduced so that the vessel will be able to mount six 4.7 in. and six 3 pounder rapid fire guns and four machine guns. At sea the speed will be about 18 knots.



VIEWS SHOWING THE PRESENT CONDITION OF THE AMERICAN LINER PHILADELPHIA (FORMERLY THE PARIS), UNDERGOING RECONSTRUCTION IN DRY DOCK AT BELFAST, IRELAND.

A YEAR'S EXPERIENCE UNDER THE PROVISIONS OF THE PERSONNEL BILL.*

BY ENGINEER-IN-CHIEF GEO. W. MELVILLE, U. S. N.

In his annual report for 1900 Engineer-in-chief George W. Melville, U. S. N., devotes a special chapter to the consideration of the personnel question in the light of another year's experience under the provisions of the Personnel Bill. In plain language he calls attention to present conditions which manifestly are not helpful to a proper condition of efficiency of our naval vessels. There is, he points out, an entirely insufficient number of officers possessed of sufficient engineering knowledge to exercise intelligent supervision over the engine room staffs of our war vessels. This condition of affairs existed prior to the passage of the Personnel Bill, when the former corps of Naval Engineers performed engineering duties only, and from the report of the Engineer-in-chief, the Personnel Bill as now enforced not only does not afford any relief in this direction, but even intensifies the serious condition which its advocates claimed it would cause to disappear. On account of the importance of the subject we here reproduce the statement of Engineer-in-chief George W. Melville in full:

PERSONNEL.

Another year of experience under the provisions of the "personnel bill" finds the status of steam engineering interests in the Navy even less fully protected, and the number and condition of the force for their control even less satisfactory than when I made my last annual report.

The magnitude of the work under this Bureau has rapidly increased with the additional ships in commission and the new ships building, while there has been a further decrease in the number of skilled officers available for supervising this work and but few signs of speedy replacement.

I am fully aware of the futility and folly of decrying legislation simply because the desired results therefrom do not promptly materialize, but surely time enough has now elapsed since the enactment of the reorganization scheme to make criticism of its effects upon the Navy both proper and important.

To any close observer it is convincingly evident that either the scheme was a mistake, or that the proper course has not been taken to carry out its intent.

I am free to acknowledge that the events of the past year have brought only discouragement to those most deeply interested in a successful outcome of this new law, but I am equally candid in the belief that the cause of this discouragement lies not in the scheme itself, but in a lack of full appreciation, on the part of the Department, of the urgency of the need for haste, not only in providing the fullest opportunity for the acquirement of practical engineering knowledge on the part of the younger officers of the former line, but in enforcing their embracement of this opportunity in the most effective manner by Department orders. It will not do to depend upon unaided individual enthusiasm or details occasioned by the necessities of particular ships. Such a course merely temporizes with the present needs, fails in any rational degree to increase the force of naval engineers (even should it suffice to replace the annual loss), and is hopelessly ineffective to secure the most desirable results in the shape of a speedy acquirement of general knowledge of engineering on the part of the new line as a whole.

There is an immediate and constantly increasing demand for more expert engineer officers with which to protect the interests of the Government efficiently. This demand can only be met by assigning at once, both ashore and afloat—and in as great numbers as possible consistent with absolutely necessary other duties—the younger line officers as understudies and assistants to the experienced engineers now in charge of engineering work. In no other way can the wished for result be quickly obtained. With a full opportunity provided, I am confident there will be no lack of interest or energetic application on the part of the officers detailed.

In a number of cases former line officers have had charge of the machinery of vessels during the past year, and while, in some instances, owing to lack of experience, their control has not been marked by all desirable efficiency, in no instance has there been evidenced any carelessness or lack of close attention to the work. On the contrary their devotion to the new duty has clearly been indicated.

With steam engineering as a line duty this is pleasing to those who formerly had its entire control, and whose greatest fear might naturally be supposed to be that no efficient engineer officers would succeed them, and that the machinery department of ships would eventually be controlled by men of a more purely practical education (machinist) incapable of maintaining that constant stress toward increased efficiency found so needful to advance or of retaining the proud position of steam engineering of the United States Navy at the head of the marine world.

In my last annual report I endeavored to express the unsatisfactory conditions clearly, but after the lapse of another year a review of these conditions, with additional experience, is necessary.

First, there are available over one hundred less engineer officers than just prior to the personnel act, and at which former time I had good cause to ask for an increase in the full number then on the list.

With this great decrease in numbers came an increase of work, making it a necessity to

*From the 1900 report of the Engineer-in-Chief of the Navy.

curtail the usual and needed allowance of engineer officers for ships until the largest could have but one, and the colliers and smaller ships often none. To the latter were assigned, in most cases, former line officers as heads of the steam engineering department, these depending principally upon the machinists for expert directions. That many casualties have not resulted is not, however, due to the propriety and efficiency of this arrangement, nor does it indicate a safe and commendable condition, for it has only been by dint of the most anxious and continuous care on the part of the depleted force that mishaps and breakdowns have been infrequent. In other words, a state of tension has existed and now exists under which it is neither wise nor safe to continue a day, as it is sapping the energy of good men. Instead of building up a personnel for the day of need, stronger than necessary for the time of peace, the engineer officers and men are kept at the point of elastic limit, and a new war to-day could not fail to develop a large list of physical incapables in the engineering branch the moment the additional burden was put upon them. True, we could call upon the civilian expert for help and no doubt secure many good men, but how foolish to deliberately lean on this uncertainty when it is possible to school our own intelligent and devoted officers to a degree of satisfactory efficiency. That this schooling will eventually be accomplished I still believe; but my earnest request is for a greater effort to hasten it in order that no day of need will find us sadly wanting. I urge you to decided steps toward this object, pointing again to the fact that, at the present rate, new expert engineers are not being made in any rational proportion whatever to the displacement of the old ones from the active list, if indeed they are being made at all.

You are fully cognizant of the intricacy and extent of the engineering department of a large ship. That of a smaller one bears the same importance and carries the same danger for the inexperienced. You can, therefore, judge how impossible it is to create in a few months expert engineers from even the most intelligent officers unused theretofore to machinery. Experience daily under all conditions of service alone perfects efficiency, when combined with intelligence, and it is this experience I ask shall be given to all line officers possible, below the grade of lieutenant-commander, both at sea and ashore. From the many we are sure to gather a fair proportion particularly adapted to the work and with natural proclivities toward mechanics. These will be the real additions to the engineering branch, and will increase as greater numbers come from the Academy. The others, fairly well versed in time, will fill the gaps in emergency or war, and with a universal general interest there will be no need to call for volunteers to man our ships in this department.

Regarding the engineering departments of ships at sea in times of peace as well as war, compare for a moment the condition of a battleship depending for the full and proper operations of her motive power upon the knowledge of a single officer, the chief engineer, with that of another ship of the same class whereon any one of the line officers could, in emergency, take efficient charge of the machinery, and several indeed assume and completely fill the position of an expert in that department. The ideal condition of the latter is what we are now striving for, since engineering knowledge has been recognized as of the most vital importance in the service, and it is to the realization of this I still hopefully look, despite the many visible obstacles.

That I should betray unusual anxiety on this question can only be through my intimate knowledge of the conditions now existing and my earnest interest in the welfare of the service. My views, I can properly say, should have more weight upon this point than the views of any other naval officer or board, as these can not view the situation from as comprehensive a standpoint as can the Engineer-in-chief, upon whose shoulders for years has been the special care and protection of naval engineering.

Inattention to my recommendations or apathy regarding the immediateness of the necessity for more active and decided measures toward securing the desired conditions can surely result in nothing but rapidly decreasing efficiency, from which it will be continually more difficult to recover, and the cost of which will be significant in enormously larger repair bills, shorter-lived machinery, and a fleet of vessels in doubtful fitness for their designed service—a Cervera fleet, with limitless men, but lacking the technical experts needed to meet the extraordinary and ever-new conditions of emergency and war.

I regret I have failed to impress you to the point of action by my former communications. Had a series of calamitous events occurred during the past year to make graphic the insufficiency of the present force of expert engineers, I am sure potent remedial measures would have been promptly taken by the Department. But while glad indeed to have disaster averted, I can assure you that danger now exists. It lurks in the silence of seeming security, but a knowledge of its presence should increase the desire to hasten its removal. Fortune alone has postponed casualty.

The country can safely count on the valor and fidelity of its officers and men, but fidelity and valor without knowledge of the use of the arms given them with which to do battle can avail little against an efficiently drilled foe, and will afford scarcely more than an exhibition of heroic sacrifice, as needless as it would

be cruel. The arms of a battle-ship are her machinery and her guns, "useless each without the other," and strong to victory when working well together. No deep thought is necessary to understand this, in the light of late experiences. The very highest degree of excellence in both the condition and handling of each is the price of successful encounter, or at least is the expectation of the country. A ship motionless or helpless to maneuver well could never make efficient battle, be her guns never so good or her crew never so brave. To guard against this the head of the steam engineering department must be full of resource and armed by experience and engineering ability only attained by years of intimate association with machinery under all conditions of service. Haphazard luck may bring a ship through without this, but sane judgment would condemn dependence on simple fortune, or a failure to use every possible effort to insure a most competent management in this most important of ships' departments.

Engineering work is as full of interest as it is of importance, and the line may well be proud to preserve the control of it. The most intelligent are eager to become experts, and with their superior advantages need no primary instruction. They do need much experience with and observation of machinery at work and under repair or construction and it is for the Department to decide upon the quickest way by which they can obtain this, and then to afford them the fullest opportunities for doing so.

I have already suggested to have incorporated in the regulations the best method for the needed training at sea, i. e., by departmental order to compel all line officers below the navigators of ships to alternate in duty in the engine room and on deck, and efficiency reports to be made quarterly to note their progress and class their ability.

My plea is for the highest efficiency; for immediate recognition of its importance as well as of its present decadence through depletion of the number of technical experts without full provision for early replacement. I hold up the warning finger and sound the note of alarm.

An official utterance on the subject by one of the "old line" officers of equally high rank, from the navigation standpoint, would be of more than passing interest at this time. In the expressive language of the street, it is "up to" the "line" now to make reply.

In a collision off the Delaware Capes, the Old Dominion line S. S. *Hamilton* ran down and sank the coasting schooner *A. A. Shaw*, of Philadelphia, October 7. The steamer hit the schooner amidships, and kept her bow in the opening until the schooner's crew had been hauled up by the ropes. Then the steamer backed out and the *Shaw* went to the bottom. The latter was an old wooden vessel carrying coal.

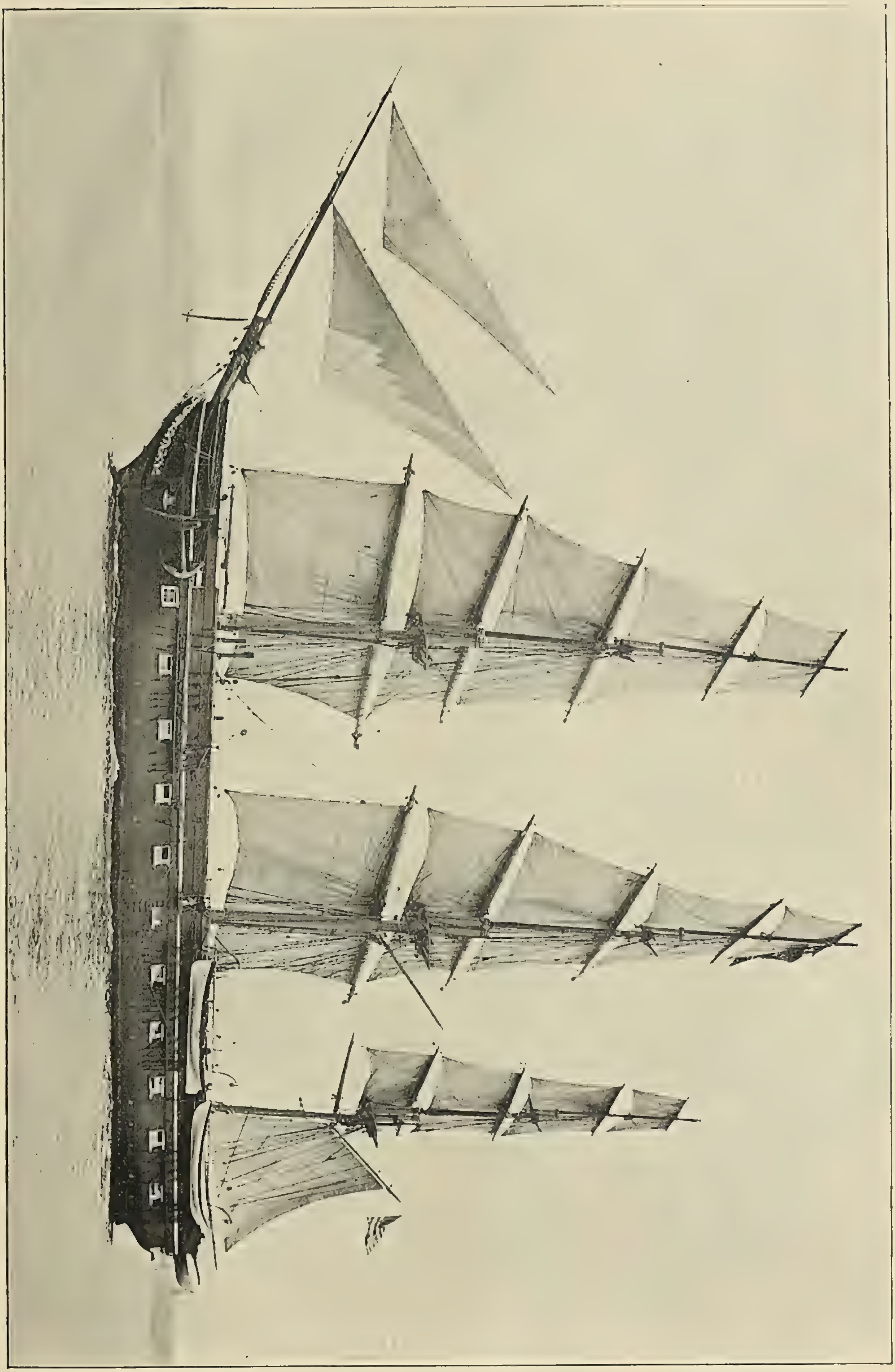
New York School Ship St. Mary's.

In the photograph of the school ship *St. Mary's*, of the port of New York, is shown the present appearance of a famous old ship of the American Navy. This vessel has lately undergone an extensive overhaul at the New York Navy Yard, and returns to her work of education with a new lease of life. Her construction antedates the Civil War, she having been put into the water at Washington, D. C., Navy Yard as long ago as 1844. She was named for one of the most influential counties in the State of Maryland. The *St. Mary's* is still carried on the roster of naval vessels, being classed as a "wooden sailing vessel." In her day she ranked as a powerful war vessel, her dimensions being: length between perpendiculars, 150 ft.; beam, 37 ft. 6 in.; mean draft, 15 ft. 6in.; gross tonnage 766 tons, and displacement 1,025 tons.

When built she was fitted with a battery of smoothbores containing six 8-in. and sixteen 32-pounders, all muzzle loaders. Her first assignment to active duty was during the Mexican war, when she was in Vera Cruz. Later her work was in the Pacific, where she remained throughout the Civil War protecting merchant vessels from Confederate cruisers. It was toward the close of that war that the *St. Mary's*, Captain Colvocoresses in command, saved the port of Valparaiso from bombardment by the Spanish fleet. Her commander placed the ship between the principal city buildings and the Spanish squadron and declined to move when requested to do so by the Spanish admiral.

In the present service of this vessel the mistake is often made of supposing it to be a reformatory for the discipline and moral improvement of bad boys. On the contrary, the vessel is a school ship pure and simple, and very rigid inquiry is made into the character of all applicants for admission. The vessel is officially known as the New York Nautical School, which is conducted by the Board of Education of the City of New York. Candidates must have either a parent or guardian residing in New York, and must be between the ages of 16 and 20 years, of sound constitution, and have shown a disposition to follow the sea. Every candidate has to pass an educational test, and has to provide an outfit, and pay $25 on admission to cover the cost of uniform and bedding during the course. The course extends over two years, and includes two summer cruises.

When in port the vessel is tied up to dock in the Hudson River, and when on a cruise, the waters of Long Island Sound are usually sailed in until the pupils can easily handle the ship, and then New England ports are visited. On a foreign cruise, the *St. Mary's* calls at English, French and Spanish ports, and touches at the Madeira Islands. At sea, the time of the pupils is given almost entirely to the study and practice of professional branches of seamanship, and while in port, more time is devoted to theoretical work. At the present time many former pupils of the school are actively employed in responsible positions by our great merchant lines, and indeed this school is doing no small share of the work of upholding the American Merchant Marine. Commander W. H. Reeder, U. S. N., is superintendent of the school.



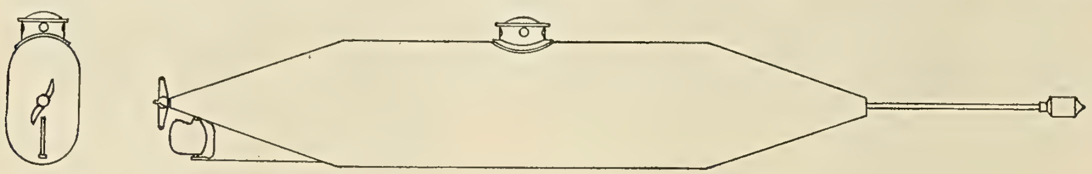
PUBLIC SCHOOLSHIP ST. MARY'S, OF THE PORT OF NEW YORK—A FAMOUS FORMER FIGHTING SHIP, NOW CLASSED AS A WOODEN SAILING VESSEL, OF THE U. S. NAVY.

SUBMARINE BOATS—FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—II.

BY CARL BUSLEY.

CHAPTER VI.

McClintock's and Howgate's David, 1863.—During the War of the Rebellion, McClintock and Howgate built a submarine boat which was the means of the destruction of the Union sloop *Housatonic.* The shape of this boat can be seen in Figs. 14 and 15. It was about 42 ft. long, and was built of boiler plate. The crew consisted of eight men, of which one man was at the helm, and the other men turned the two bladed propeller by means of cranks The boat was supposed to have attained a speed of four knots. It has been asserted that the boat could dive to any depth, and remain there a half hour with the whole crew in quiet water, although authentic reports of her trials do not seem to agree with this assertion. The idea of the boat was to tow a mine close under the keel of an anchored vessel, and to explode the mine through contact with the bottom of the ship. Lieut. Paine, of the Confederate Navy, with eight volunteers, undertook to attack the Union vessels. While the boat was being prepared the swell of a passing steamboat splashed into the manhole, sinking her. The eight volunteers were lost, and Lieut. Paine succeeded in getting out, as he was standing at the manhole at the time. After the boat had been raised, Lieut. Paine made another attempt with eight other volunteers, but the boat ran ashore at Fort Sumter and capsized. On this occasion there were six men lost of the crew, and only the Commander and two men were saved. After the boat was raised for the second time and put into shape, an engineer named Aunley, who had been busy with the reconstruction, attempted a trial trip in Cooper River. While totally submerged his apparatus for getting to the surface must have become deranged as the boat did not rise again, and it was only recovered three days later. The entire crew were, of course, dead. The next trial was undertaken by Lieut. Dixon, of the Twenty-First Volunteer Regiment. He left the harbor with eight volunteers on the 17th of February, 1864, and succeeded in destroying the Union sloop *Housatonic,* which lay at anchor in the outward harbor of Charleston. He had somewhat changed his plans as the attack was not made by means of mines, but was made with a pole torpedo; also the boat was not entirely submerged. During this time the manhole was left open so that the men could breathe more easily. Aboard of the *Housatonic* the boat first gave the appearance of a floating block of wood, and the crew of that vessel only became aware of their danger when it arrived within about 300 ft. They immediately slipped their anchor and started their engine, and called the crew to the guns, but before a shot could be fired—it was about two minutes after the boat had been sighted—the explosion occurred, and the *Housatonic* sank immediately. Of her crew only five men were killed and the remainder saved themselves by climbing into the rigging which projected above the water. The submarine boat, however, did not succeed as well, as the wave caused by the explosion washed into the open manhole, causing it to sink, and for the last time its entire crew were buried under the waves. The Confederates had lost already thirty-two men by this trial, while the Federals only lost five men, which would not speak very well in favor of the submarine boat. Too much praise, however, cannot be bestowed upon the personal courage and the soldierly spirit of the Confederate volunteers, who were always ready to take the place of the unfortunate crew after the boat's former misfortunes.



FIGS. 14 AND 15.—MCCLINTOCK'S AND HOWGATE'S DAVID, 1863.

CHAPTER VII.

Value of the Pioneer Boats.—All the submarine boats which were propelled by man power were of radically different shapes, and forms, which as a question of standard type cannot be considered at all. They were all of comparative modest dimensions, and on the average did not exceed 50 ft. in length and about 30 tons displacement. Furthermore, their speed of four knots was so slow that the crew could only expect a successful issue of their attack when those on the attacked vessel were perfectly unaware of their presence. The diving of these boats (omitting the highly problematical Bushnell's diving propeller), was always effected by taking in water ballast, and rising to the surface by ejecting this ballast by means of hand pumps—a very tedious operation, and requiring time. The difficulty in renewing the air supply was mostly avoided by remaining under the surface of the water only for such a length of time as the contained air would permit. The weapon of attack was first the mine and latterly the pole torpedo. The whole arrangement of these boats is of such a nature that very little confidence would be now placed in them, and it is surprising that it was so easy to find crews to operate them in addition to their inventors.

CHAPTER VIII.

Submarine Boats Entirely Submerged, Alstitt's Boat, 1863.—During the war of the Rebellion the submarine boat designed by the American, Alstitt, was a radical change from the former styles, and opened a new era in the construction of submarine boats. In the first place, it was not driven by hand power, but was operated by means of steam and electricity, and its construction, as shown in Fig. 16, was that of a complete small boat of about 75 ft. long and 10 ft. deep.

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.

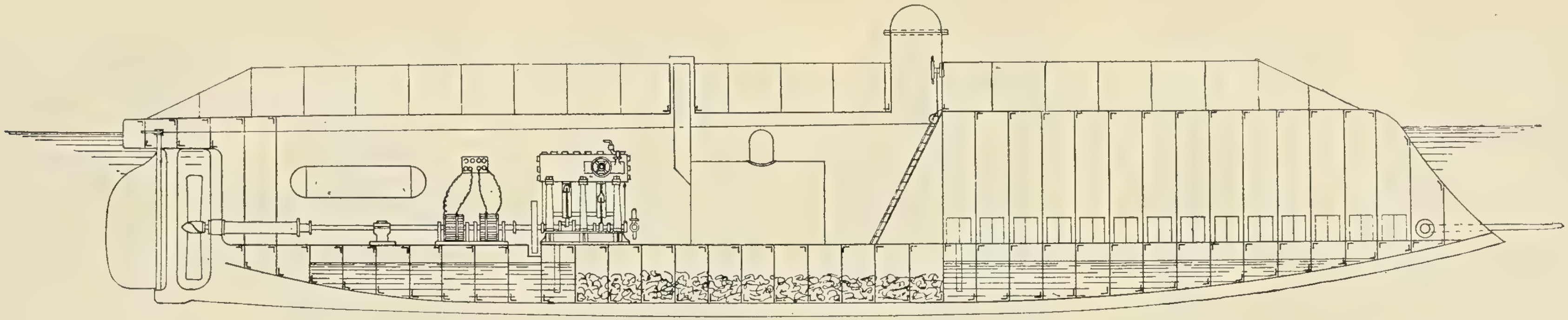
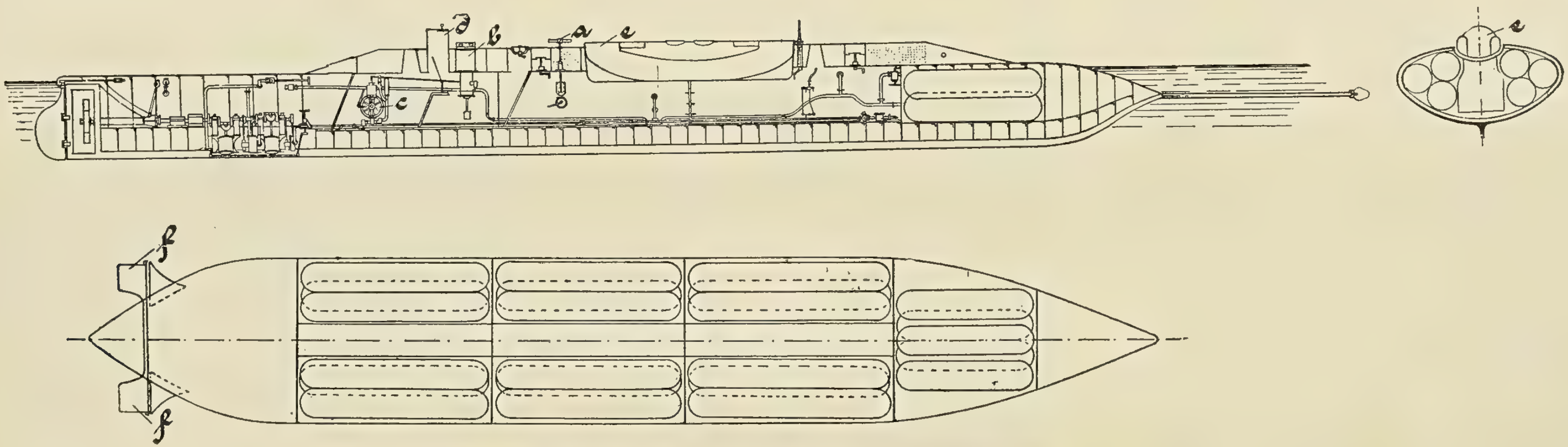


FIG. 16.—ALSTITT'S BOAT, 1863.



FIGS. 17, 18 AND 19.—BOURGOIS' AND BRUNS' PLONGEUR, 1863.

As long as it sailed on the surface the steam engine was used, but when diving the electric machine was the propelling power, after the fire was drawn from the boiler. The boat had a double bottom, which held the water ballast at both ends, and in the middle held the coal for the boiler. The after part of the engine room was fitted with a cylindrical receptacle for compressed air for the use of the crew when the boat was submerged. At her bow a mine was attached similar to the style of a pole torpedo. Even if Alstitt did not have an opportunity to develop his ideas, as the boat was not built, it must be conceded that his idea, especially that of the propelling power, corresponds to the present practice.

CHAPTER IX.

Bourgois' and Bruns' Plongeur, 1863.—About the same time that Alstitt designed his craft, Admiral Bourgois and Marine Constructor Brun were building the submarine boat *Plongeur*, for the French navy, and which was launched at Rochefort in May, 1863. According to Figs. 17, 18, 19, it was about 140 ft. long, 19 ft. wide and 11 ft. deep, and had a displacement of about 450 tons. This displacement exceeds that of the modern torpedo boat destroyers. The six-bladed propeller was driven by an oscillating engine, using compressed air. The

compressed air was stored in cylinders as shown in Fig. 19, which occupied the greater part of the ship's body, and were stowed in separate water-tight compartments. The exhaust of this air was used for breathing by the crew while under water. Diving was effected by admitting water into the ballast spaces in the double bottom, and the depth of the dive was regulated by a vertical propeller, *a*, and a cylinder, *b*, with a tight-fitting piston, which increased or diminished the volume of the boat, and in addition the horizontal rudder, *f*. The ballast water was ejected by means of a pump, *c*, also driven by compressed air. The manhole is indicated by *d*, and *e* was a life boat, connected to the body of the larger boat by means of water-tight doors, and which could be readily detached from the ship's body. Her bow was fitted with a pole torpedo. The boat made a number of trials in the harbor basin at Rochefort, and also at La Pealisse, and it was demonstrated that when she was completely submerged, she lost her fore and aft stability, owing to her great length, as when she was sailing in a submerged condition she was either bumping the bottom or coming to the surface. For this reason she was placed out of commission in 1864 and broken up.

CHAPTER X.

Vogel's Boat, 1868.—During the years 1867-72, Vogel, of Dresden, had worked on the plans of a submarine boat, shown in Fig. 20, and did not succeed in getting beyond the first trial. The boat was built at the former Schlick's yard, in Dresden, in the year 1868. Her dimensions were: Length, about 16 ft.; depth, 4 ft. Her construction consisted of T iron frames and iron shell. Her propelling power consisted of a three-cylinder steam engine, *a*, which drove the propeller by means of belts, *b*. When floating on the surface the engine worked high pressure, and when submerged it worked with a condenser. Steam was generated by means of oil fuel. Oil was stored in the receptacle, *c*, and ran by gravity into a burner which, as shown in Fig. 21, consisted of a perforated copper pipe. The gases of combustion were discharged into the chimney, *e*, when floating on the surface, and when underneath the water were discharged into the receptacle, *g*, in which the temperature was reduced by means of a spray of water, which was forced into it by the pump, *h*. For the separation of the soot the coal gases were to be ejected clear of the boat by means of two air pumps, *i* and *i*, directly attached to the engine through the discharge pipes, *k*. In order to dive, the double bottom was filled by means of a cock, *l*, and to come to the surface the water was ejected by means of the hand pump, *m*. Vogel intended to use a torpedo as his weapon, but did not state how it was to be carried or operated. He predicted that his boat would be able to remain submerged for three hours. According to correspondence which he had with the German navy up to the year 1872, it appears that he did not make a successful submerged trip in the river Elbe, as intended.

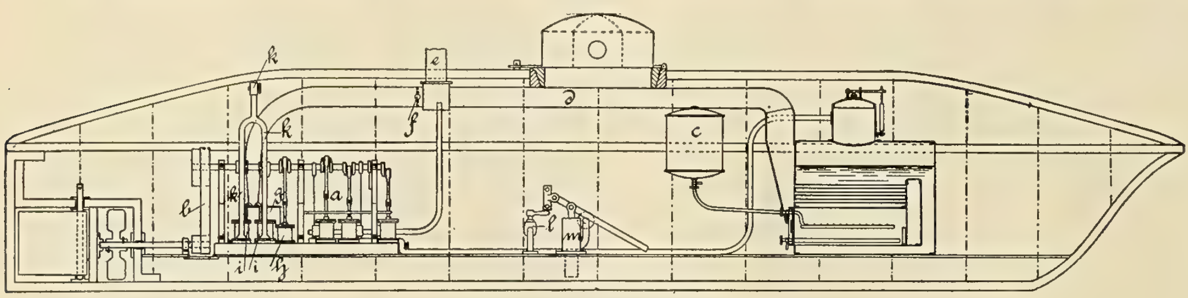


FIG. 20. VOGEL'S BOAT, 1868.

CHAPTER XI.

Drzewiecki's Boat, 1884.—The Russian engineer, Drzewiecki, in the year 1877, built a small submarine boat about 13 ft. long, driven by means of a propeller. As the boat had accommodations for only one man, this propeller was worked by means of a treadle, combined with a tooth-wheel gear. Both sides of the dome in which the man stood were fitted with leather gloves to enable the operator to attach mines to the vessels which were to be attacked. In 1879 Drzewiecki designed in St. Petersburg a somewhat larger boat, about 20 ft. long and of sufficient capacity to hold four men and the commander. The diving outfit consisted of the usual water bottom, with means for letting in the water or pumping out the same. When the boat was in motion it was canted by means of two weights, to enable it to sail to the surface or to get beneath the surface. These weights were attached to chains, so that the middle weight would move forward at the same time that the after-weight moved towards the middle, when it was required to dive to a greater depth. When it was required to come up the forward weight was moved to the middle, and the other weight was moved aft. Drzewiecki attached a tube fitted with prisms in order to be able to see objects above the surface. Finally, in 1884, he designed a submarine boat, as shown in Fig. 22, in which the propeller was driven by means of dynamos and accumulators. The two moving weights of his first boat were replaced by a single one, and, as the figure shows, this weight could be moved by means of a chain from one end of the boat to the other, and it was guided in a tube

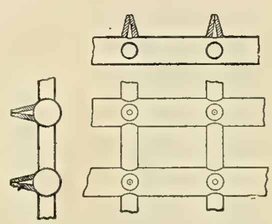


FIG. 21. OIL BURNER, VOGEL'S BOAT.

in the ballast space. It was reported at one time that the Russian Navy was going to build fifty-two of these boats as equipment for their battleships, but this evidently must have been only the hope of the inventor, as nothing further was heard in the matter.

CHAPTER XII.

Tuck's Peacemaker, 1886.—In 1884 an American, Professor Tuck, made experiments with a submarine boat, with a length of 30 ft. and of 10 tons displacement. This craft was driven by means of storage batteries, and was said to have attained a speed of 6 knots. It was fitted with two Fish torpedoes, which were attached to the boat by means of electro-magnetic claws. The latter could be operated from the inside of the boat in such manner that the torpedoes could be released at any moment. The boat had one bad feature; the outfit for renewing the air consisted of two pieces of hose, each terminating in a float which rested on the surface of the water. Fulton had tried the same thing, and Tuck had the same misfortunes that his predecessor encountered. In 1886 Tuck built a second boat, called the *Peacemaker* (Figs. 23 and 24), with a length of 30 ft.; 8 1-4 ft. beam, and 5 1-2 ft. deep. It was propelled by a 14 horse-power Westinghouse steam engine, and with 350 revolutions, the boat is supposed to have attained a speed of 8 knots, not beneath the water, as has generally been reported, but floating on the surface. In order to stiffen her light construction she was fitted with a fin keel on top, with a depression in the middle, the latter being intended to give her a better hold under the keel of a vessel. On either side of the dome, as well as at both ends, watertight gloves were fitted to facilitate the placing of the torpedoes, which, in this case, as well as in the first Tuck's boat, were carried on the sides. It has been reported that the *Peacemaker* remained at a depth of 53 ft. for a period of 7 minutes. Another time she is said to have steered a course under water in which she sailed under two vessels, and at still another time, to have dived under a tugboat without having been observed by the crew of the tug. In spite of all these so-called successful trials, the *Peacemaker* has never been pronounced a permanent success.

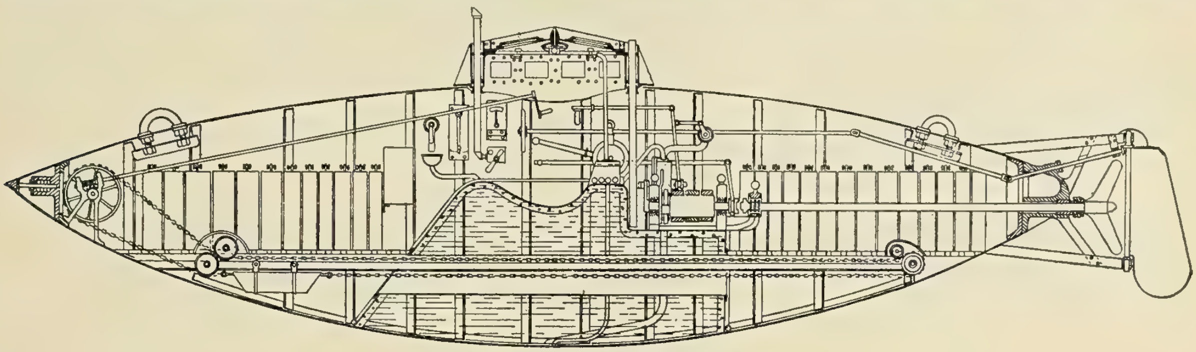
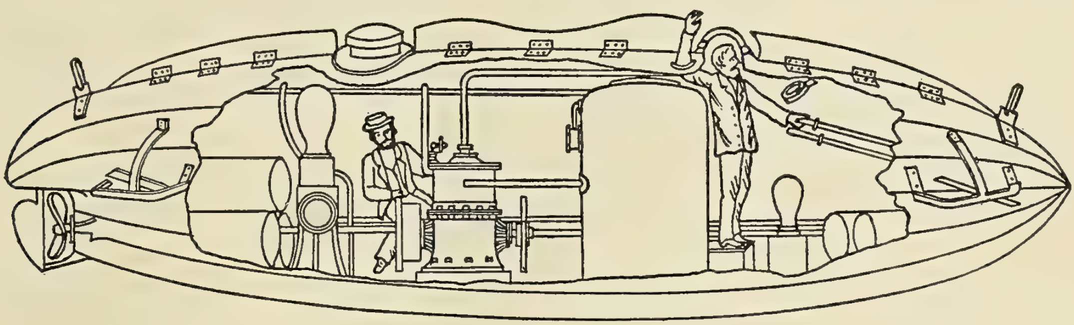
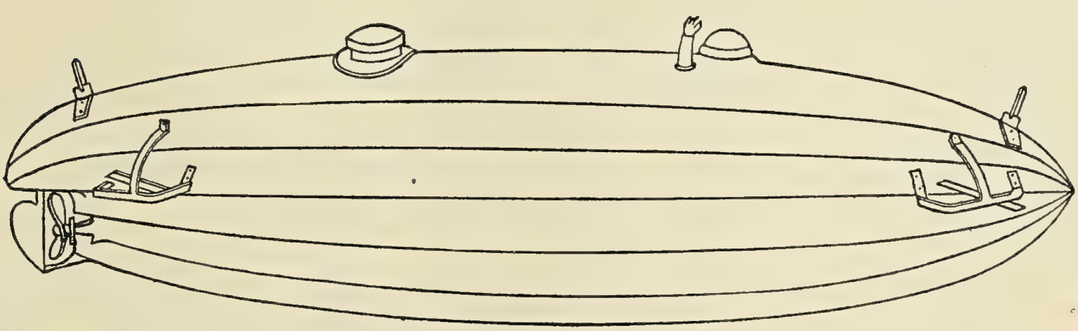


FIG. 22.—DRZEWIECKI'S BOAT, 1884.





FIGS. 23 AND 24.—TUCK'S PEACEMAKER, 1886.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.*—III.

BY LIEUT. R. H. JACKSON, U. S. N.

In order to have present practice abroad in a readily available form, the following table has been arranged, which is fairly accurate, the conflicting statements of the different sources of information upon this subject making it very difficult to obtain correct data.

Nation.	Type.	Built.	Building.	Displacement.	Length.	I. H. P.	Speed.	Armament.
England	Destr.	108	10	300	210	6,000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	98	..	....	....	....	..	....
France	Destr.	4	8	300	185	4,800	26	1 9-pdr, 6 3-pdr. 2 T.
	Boats	211	8	152	144	4,200	30	2 3-pdr. 2 T.
Russia	Destr.	1	28	240-350	196	3,800	27	3 1-pdr.
	Boats	174	17	120	....	....	..	....
Germany	Destr.	1	5	350	210	5,800	28	5 3-pdr 3 T.
	Boats	113	9	155	157	2,500	25	1 R. F., 1 mch. 2 T.
Italy	Destr.	....	8	320-350	196-208	6,000	30	1 12-pdr., 3-5 6-pdr. 2 T.
	Boats	142	2	150	156	2,700	25	2 1-pdr. 2 T.
Japan	Destr.	....	8	275-300	220	6,000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	44	12	130	148	2,000	26	2 3-pdr.
U. S.	Destr.	....	16	420	245	8,000	29	2 12-pdr., 5 6-pdr. 2 T.
	Boats	20	11	165	175	3,000	26	3 3-pdr. 3 T.

REQUIREMENTS OF DESTROYERS.

Speed.—The boat must have sufficient speed to overhaul a torpedo boat and disable her. It is well to remember that at night the discovery will be made at close range, and but a slight superiority in speed will be sufficient to enable the destroyer to close sufficiently to prevent the boat from eluding her, and enable the gun captain to hit his indistinct and difficult target. The flare from the stack of the fleeing boat, when she is pressed to her limit of speed, will materially assist the destroyer unless the rain, snow, or fog intervenes. In daylight the discovery of the torpedo boat is not likely to be made at more than five or six miles, so that a difference in speed of three knots would give the destroyer the necessary superiority. A speed of 28 knots that can be maintained for six hours is sufficient for all purposes, and gives a surer indication of the value of the boat than a delusive 32 knots with bottled-up steam over the measured mile. To attain this result the machinery must not be shaved too light. The results of the performance of some of these boats abroad during the last years indicate that the factor of safety is too small, and that the number of revolutions allowed is beyond safe practice, making the strain on the moving parts tremendous; any slight flaw in forging or tempering, and the engine-room is a wreck—if there is no worse result. Let us not be carried away by the desire for the fastest boat in the world. Moderate revolutions and steam pressure and staunch machinery, and we can challenge the speeds shown in the table, and feel that we have the better boat.

Armament.—Five 6-pdrs., one 12-pdr., two tubes, and two torpedoes.

The argument in favor of this battery is found under the head of Criticisms on Ordnance.

From the table it is seen that our armament is still the equal of any nation, and superior to most, except in the number of torpedoes carried on board. It is well to bear in mind that some of the boats do not in practice carry *both* torpedoes and guns; one or the other is left ashore.

A liberal allowance of coal and water must be carried, remembering that at night the boats must be actually cruising. During the day, by running slow under one engine, and carefully tending the two large distilling plants that are needed, she can replenish her water supply. In case of necessity, coal and water can be supplied from the big ships, such as the *New York*, and the distiller ship; but it is best to be self-supporting, as weather and unusual circumstances may make assistance impossible.

Displacement.—Before deciding upon the size it is well to bear in mind the two distinct rôles in which the destroyer appears.

First.—She is a terror to all torpedo boats; her powerful battery, relatively high speed in all weathers, and shallow draft, leave them but little hope for escape, unless a lucky shot at long range disable her. In this rôle she acts as the night policeman for the fleet, easing the nerves of the battleship.

Secondly—and this is a point that is likely to be forgotten—she is a terror to the enemy's fleet; for not only does she carry the same torpedoes, and will appear from more distant points, but she still retains that essential element to successful attack by surprise, a relatively small size and consequent invisibility. It is the failure to recognize this essential quality that has led to the advancement of a type of boat of 600-800 tons displacement, which is based on the sound doctrine "the bigger the better," when coal endurance, stanchness, comfort, and speed are the qualities desired. The "low, long, rakish, craft," this invisible terror of the seas, must be retained, as in the piratical days of old, to destroy a few and strike consternation to the hearts of all.

We have reached the happy result, but the outside limit, in our 420-ton destroyer. It is well to remember that foreign practice tried this 800-ton boat several years ago, in their "avisos" and scouts, which were afterward abandoned, and then developed the torpedo boat to its present size. By examination of the table it will be seen that even now we lead all other powers in the displacement adopted.

TORPEDO BOATS, CLASS P.

Requirements.—Only sufficient speed is needed in vessels of this class to make it possible to overhaul and attack a distant fleet cruising at a moderate speed.

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

Twenty knots is thought to be a good sustained speed for an all night run in moderate weather. This would give a 25-knot speed for the dash to escape after the attack. A boat that can be relied upon to do this should be able to maintain a speed of 25 knots for six hours in smooth water.

A flotilla of these boats would temporarily accompany the squadron till the commander-in-chief decided upon the point of attack, or received information of the enemy which would permit a blow from this mobile arm of his fleet. After the attack the flotilla would probably return to the nearest base. They are expected to join the fleet whenever needed, and to remain till the attack has been pressed home. But the admiral would leave them resting on a convenient base till the time seemed ripe for the blow.

The armament thought best is three S. A. 6-pdrs., two tubes, and two torpedoes. The reason for this selection is found under Criticisms on Ordnance.

Displacement.—The displacement must be kept as small as is consistent with sea-going power. These boats must be able to keep with the squadron in all weather; and have a crew, coal, and water, sufficient to be counted on for a week, and still be able to return to port. The *Porter* seems to have been able to fulfill these conditions under the test of war; yet no smaller boat seemed to be able to come up to this requirement, so that 165 tons seems to reach the sea-keeping power combined with a size that permits of a successful surprise in a night attack. Great Britain alone has recognized that boats of a smaller type than this fail to attain this sea-keeping requirement. She reported adversely upon her largest torpedo boats in 1896, and since then has built nothing smaller than the destroyer. The table shows that France and Germany are trying 150-ton boats, their first venture in boats of such great displacement, France, alone, with her desire for the marvelous, stipulating a speed of thirty knots. Twenty-five knots maintained speed answers all requirements. The table shows that for our 165-ton boat, the armament is superior to that of any boat abroad; but three 6-pdrs. would make her a Tartar for destroyers and small gunboats.

STATION BOATS, CLASS Q.

There does not seem to be any need for this class in the scheme for coast defense, and they are not sufficiently powerful for offense. So that though the ten that we have thus far acquired are quite useful for drills and exercises in our home ports, and will make good station boats for the West Indies, there seems to be no reason for duplicating any of the six types represented by the ten boats in this class.

As for the *Manley*, no one seems to know for what she was designed or why she was bought. Possibly, it was to give us wrinkles in design and construction. This was a reason that I heard advanced for the purchase of the *Somers*. This boat, 150 tons, has but a single screw, and when the attempt was made to bring her over she leaked so badly as to require her return to port. After the war she was brought over in a freight steamer. She has the lines typical of all the Elbing boats. She carries an underwater bow tube, which may have been the cause of her trouble. At any rate, Germany has lost three boats by foundering at sea, and it is thought that they were on these lines, though smaller. In the latest sea-going German boats there is no submerged bow tube and no forward conning tower.

STATION BOAT, CLASS R.

As already stated, twenty boats of the *Talbot* type, with a 1-pdr. forward and a machine gun aft, would cover the conditions for the defense of the waterways and harbors.

Having decided upon our general type, let us examine the details of construction, equipment, &c., on board our boats to see if they have stood the best test of their value, viz., satisfactory results on boats in commission. This examination will be taken up according to the classification by departments on board ship. The writer is encouraged to make this minute and detailed examination by the generous desire shown by the bureaus concerned to make the changes suggested, and remedy the faults where a remedy could be pointed out.

DETAILED CRITICISM AND COMPARISON OF CERTAIN POINTS IN CONSTRUCTION.

In no way is the difference between an experienced builder and the novice so evident as in the details of hull construction, and its fittings, and in the use of some little device learned by experience, which often adds materially to the efficiency and comfort of the boat.

Consequently, the writer does not believe that any detail is too trifling to criticise, especially if a remedy is easily found. A striking example will first be given to illustrate the point, before going into an enumeration of details.

A large ventilator was placed over a cabin in order to give fresh air to the sleeper. The result was a wet bunk all the time; at sea it was salt water; in port, rain or sweat from the plate on the inside. In practice the bottom of this ventilator was kept tightly closed by a plate, and the canvas hood placed on the outside when going to sea.

Ventilators.—Experience would indicate that all attempts to ventilate compartments by means of small ventilators are failures. The discomforts and damage inflicted by salt water and rain more than offset the possible advantage of these few small air pipes. The only exception to this is for the compartment containing the closets, where there is usually little to spoil by salt water.

With this exception, there should be no opening in the deck from one end of the boat to the other except hatches and coal bunker scuttles. The hatches should be arranged with some device allowing them to remain open and yet keep out rain and spray, even though occasional seas sweep on board.

On one of the boats of the *Winslow* type, canvas hoods were fitted over the hatches of the principal compartments (i. e., the living spaces and the engine rooms), which were lashed around the hatch coaming and carried up about two feet, and the opening left on the lee side. These were only put on in bad weather. An excellent device is found on some boats. The hatch hood is a quadrant of a cylindrical section, one side fitting over the hatch, and the other open to the air, ordinarily looking forward. The upper half

of the periphery opens or closes by a sliding shutter. Shutters, either sliding or swinging, can also be fitted to the side that looks forward.

The advantages of this arrangement are that: (1) In fair weather the sliding top can always remain open unless the sea would enter a hatch with 18-in. coaming; (2) in falling weather, by hauling over the sliding shutter on top, and shifting hood so that the side opening looks to leeward, no water will enter. In ordinarily good weather, with sliding shutter on top hauled back and side shutter open, entry and exit are in no wise impeded. With an ordinary cowl the hatch can not be used for this purpose. This hood of course having a rectangular base, has only four positions, abeam, and fore and aft; but its efficiency seemed little reduced thereby; while its usefulness in all weather recommends it greatly. They should undoubtedly be fitted to each living compartment, and seem to be equally adaptable as hoods for blower engines in firerooms. When fitted over blowers they should have light wire screens, say a 2-in. mesh, to prevent signal flags and wash clothes from going into the blower.

Each living space should have two openings, to facilitate exit and also to give proper ventilation. For the two principal spaces, the cabin and the crew's space, the conning tower can be utilized for one of these, and a hatch, as above described, for the other. If an old-fashioned wind sail is then rigged in the hatch or tower, as best serves, a good supply of air will be insured in these two compartments in practically any weather, a condition that has often been denied our boats. A scant supply of air at 115 degrees, and that mixed with salt water, will lay low the toughest mariner, and result in a short time in a disabled crew and boat. Few of the boats during the war, when subject to these conditions, could boast of a man who had not been seasick.

The air ports on the sides abreast the living quarters are very convenient, and, when reasonable care is taken to renew the gaskets when softened by heat or oil, are satisfactory.

Referring again to the ordinary round top cowl or hood, an objection to it was noticed which may be new. When a man is feeling his way along the deck at night in rough weather and has seized the rim of the cowl, instead of getting support from it, the cowl, revolving from his weight, has sent him stumbling against the rail with the roll of the boat; on one occasion the cowl came off and the man was with difficulty saved from going overboard.

Clear Decks.—While on this subject of ventilation and deck opening, too much stress can not be laid upon the necessity for clear decks. There should be no openings in the decks except for the blowers, the passage of men below, the coal scuttles, and a large hatch over each engine. All these, when closed, should offer an easy gangway for travel fore and aft. Especially should this be true of the coal scuttles and engine room hatches. A satisfactory scuttle, flush with the deck and reasonably tight when cared for, is a rectangular brass plate held down by dogs against a rubber gasket fitted in a score around scuttle. A passage along the decks of some of our boats on a dark night is at the imminent risk of going overboard, to say nothing of the condition of shins which is sure to exist as a result.

Deck Covering.—After a good deal of experimenting on the suitable covering for the deck, the choice now seem to lie between linoleum and grating. The most satisfactory result has been obtained by laying gratings along the line of traffic fore and aft, and holding them down by movable cleats, so that they can be taken up without much trouble, and yet will not wash overboard in a sea-way. In case of abandoning the boat these are useful as life rafts, as they can be loosened in a moment.

The only advantage possessed by linoleum over gratings is a reduction in weight, and this is not great; its disadvantages are: (1) Lack of durability, being easily punched full of holes and torn around the edges; (2) difficulty of securing it to the deck, as on any other than flat deck boats the first sea will catch under a loose edge and rip up a whole sheet. It then requires a dry, warm day to stick it down. Also, if water lodges under it, the deck will rust badly. Then, over the fire room, the different coefficient of expansion of the linoleum and steel will always loosen those sheets.

Linoleum has been satisfactorily used as follows:

On the *Talbot* class by holding the strips over boiler-room down by 1-4 in. strips of steel along the edge secured through the deck by round head stove bolts. This system could be applied throughout, using galvanized iron or brass strips on the edge of each sheet of linoleum and holding it down with screws through the deck.

On the *Winslow,* which type, being turtle-back, have given the most trouble, a sort of combination of grating and linoleum has been adopted. Wooden strips, 3 in. wide and 3 in. apart, run fore and aft, held down by screws; under these wooden battens are linoleum strips. The arrangement prevents slipping, but as the foot finds no complete support either on the battens or between them, it would soon become disagreeable and tiresome when one moves about the deck. Rubber matting, which has been tried on some boats, is not only soon broken to pieces but is actually heavier than the grating.

New S.Y. Alvina.—The new steam yacht building at the yard of Harlan & Hollingsworth, Wilmington, Del., for Charles Fletcher will be christened *Alvina.* She is of these dimensions: Length over all, 255 ft.; length on water line, 178 ft.; beam, 26 ft. 8 in.; draft, 11 ft. 6 in. The yacht will be schooner-rigged, and will be fitted with a long continuous deck-house, with pilot-house and captain's room on top at the forward end. The machinery will consist of two sets of triple expansion engines of about 1,300 collective horse power. Boilers will be two in number, of the Scotch type, and there will be bunker capacity for 170 tons of coal. Her trial speed is placed at 14 knots.

Upon the representations of several shipbuilders, the date for the opening of the contracts for the new battleships has been postponed from November 15 until December 7 next. This will give intending bidders an opportunity to submit figures on their own designs.

S. S. HITACHI MARU, 6,172 G. T., LEAVING NAGASAKI HARBOR ON HER MAIDEN TRIP—FIRST LARGE STEEL MERCHANT VESSEL BUILT IN JAPAN.

PROGRESS IN MODERN STEEL SHIP AND ENGINE BUILDING IN JAPAN.

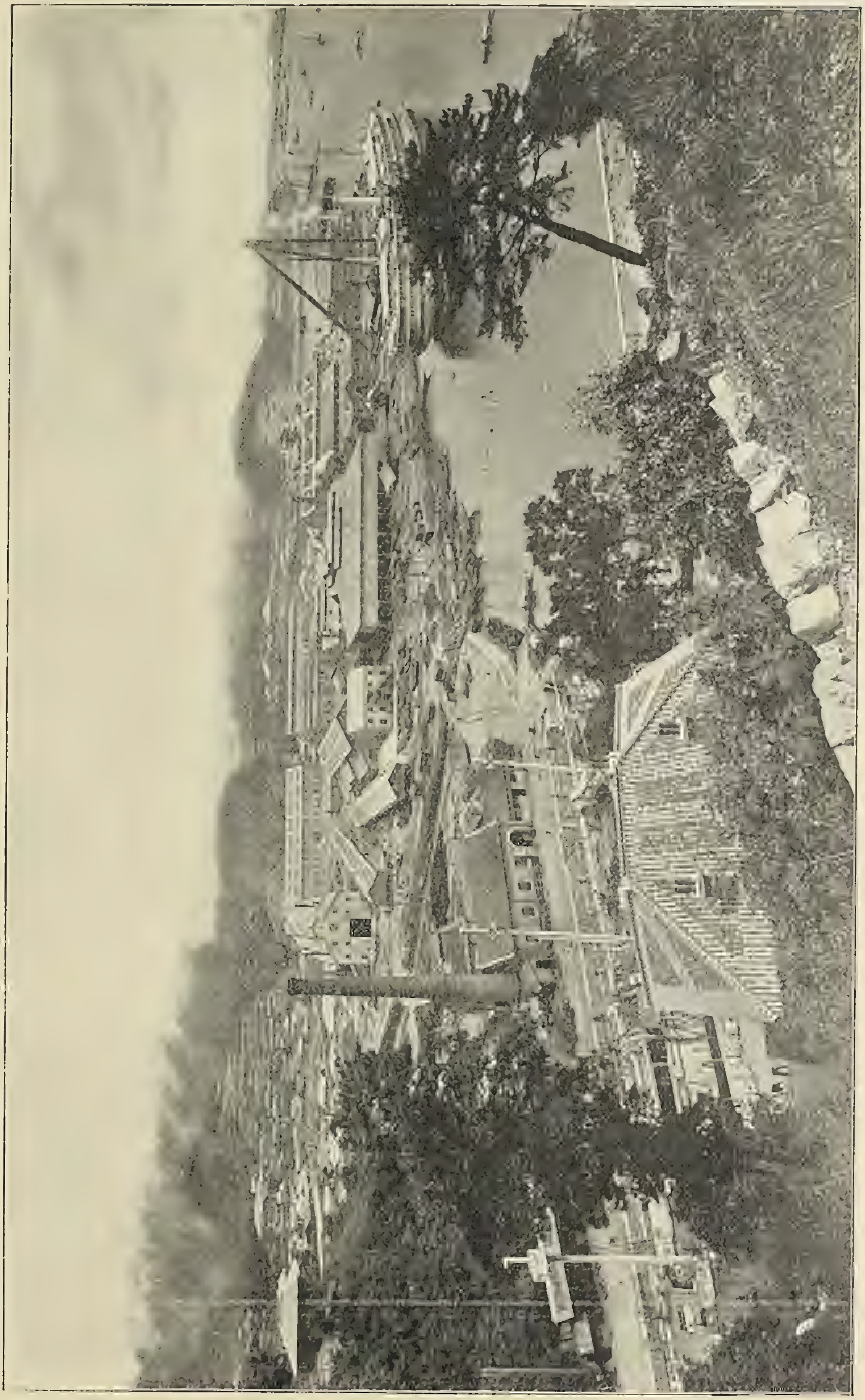
In keeping with progress in other branches of applied science the Japanese have gone ahead in the matter of steel shipbuilding at a surprising rate. The principal yard is located at Nagasaki and is known as the Mitsu Bishi Dockyard and Engine Works. It is controlled by the Mitsu Bishi Company, of Tokyo, which is owned by the family of Baron Iwasaki. This shipbuilding concern was originally established by Dutch owners in 1860, and in 1884 it passed into the hands of the present owners. Iron shipbuilding was commenced five years later.

In 1898 the first large merchant steamship built in Japan was turned out in these works. This was the *Hitachi Maru*, 6,172 gross tons, built for the Nippon Yusen Kaisha (Japan Steamship Co.) and classed 100 A1 in Lloyd's Registry. In the accompanying engraving the *Hitachi Maru* is shown steaming out of Nagasaki harbor on her maiden voyage. An idea of her dimensions can be had by comparing her size with that of the native boat in the foreground. Since that time very great improvements have been made in the establishment, and not only

GENERAL VIEW OF SHOPS AND NO. 1 GRAVING DOCK IN THE SHIPYARD OF THE MITSU BISHI WORKS IN NAGASAKI HARBOR, JAPAN.

Name of Vessel.	Hull.	Kind of Vessel.	Length.	Breadth.	Depth.	Tonnage.	I. H. P.
Tsukishima Maru	steel	sailing s. screw	238 ft.	38 ft. 6 in.	24 ft. 3 in.	1,519	305
Hitachi Maru	steel	steam tw. screw	445 ft.	49 ft. 2 in.	23 ft. 6 in. / 25 ft. 6 in.	6,172	3,888
Tategami Maru	steel	steam tw. screw	300 ft.	40 ft.	21 ft.	2,691	1,550
Toyora Maru	steel	steam tw. screw	130 ft.	23 ft.	9 ft. 3 in.	322	346
Bakan Maru	steel	steam tw. screw	135 ft.	23 ft.	9 ft. 3 in.	320	320
Awa Maru	steel	steam tw. screw	445 ft.	49 ft. 2 in.	23 ft. 6 in. / 25 ft. 6 in.	6,309	4,112
Akanoura Maru	steel	steam tw. screw	260 ft.	37 ft.	19 ft.	1,717	1,340

LIST OF STEEL VESSELS CONSTRUCTED BY THE MITSU BISHI DOCKYARD AND ENGINE WORKS.



GENERAL VIEW OF THE ENGINE SHOPS OF THE MITSU BISHI DOCKYARD AND ENGINE WORKS AT AKANOURA, NAGASAKI HARBOR—NO. 2 GRAVING DOCK IN FOREGROUND, AND U. S. HOSPITAL SHIP RELIEF LYING AT THE SHEER LEGS.

has the capacity of the yard been largely increased, but by the introduction of new tools and appliances the finest grades of work can now be successfully undertaken.

In the accompanying reproductions of photographs on pages 474, 475, the shipyard and engine works are shown. The harbor of Nagasaki is of great natural beauty, and is well adapted for purposes of marine construction, and its position geographically makes it a convenient port of call for ships engaged in the trade in the Far East, where workshops are few and far apart. The steel vessels built at the yard and delivered complete to the owners up to this date are enumerated in the table on page 474.

In addition to this new construction the yard erected three torpedo boats for the Japanese Navy and three bucket dredges, the materials for which were imported from Europe. They have also finished a number of steam launches and new machinery and boilers for various steam vessels.

In connection with the works there are two stone drydocks respectively 523 ft. and 371 ft. long by 99 ft. and 66 ft. wide, with 27 ft. 6 in. and 24 ft. 6 in. over the sills at springtide. There is also a marine railway which will lift up 1,200 tons. In the shipyard there are four main building berths as follows: One 600 ft., one 460 ft., one 350 ft. and one 300 ft.

Vessels at present under construction in the yard include:

Name of Vessel.	Hull.	Kind of Vessel.	Length.	Breadth.	Depth.	Tonnage.	I. H. P.
No. 121	steel	steam tw. screw	270 ft.	40 ft.	12 ft. 6 in.	2,221	1,800
No. 122	steel	steam s. screw	175 ft.	33 ft.	12 ft. 6 in.	581	400
No. 123	steel	steam tw. screw	445 ft.	49 ft. 2 in.	33 ft. 6 in.	6,240	5,000
No. 125	steel	steam tw. screw	445 ft.	49 ft. 2 in.	33 ft. 6 in.	6,240	5,000
No. 126	steel	steam s. screw	186 ft.	29 ft.	16 ft. 2 in.	710	520
No 131	steel	steam s. screw	320 ft.	42 ft.	25 ft.	2,660	1,550
No. 132	steel	steam tw. screw	270 ft.	40 ft.	12 ft.	2,389	1,850

In addition to the new work a very extensive business in docking and repairing is carried on.

In two years 435 vessels were handled, distributed thus:

	Japanese Navy.	Japanese Merchant Vessels.	Foreign War Vessels.	Foreign Merchant Vessels.	Total
From Oct., 1897, to Sept., 1898	15	104	31	42	192
From Oct., 1898, to Sept,. 1899	23	84	32	104	243

Among the recent additions to the equipment of the works are an overhead traveling hydraulic crane in the erecting shop of 30 tons capacity, a tripod shear legs of 100 tons capacity on the jetty, and a 105-ton boiler riveting machine. The blacksmith shop has been reconstructed and is now able to undertake any necessary forge work, having several steam hammers, including one of 7 tons. In the foundry the capacity is 50 tons. This shop has two overhead traveling cranes, one of 30 tons capacity and the other of 20 tons, and there are also five 5-ton swing cranes in the wing.

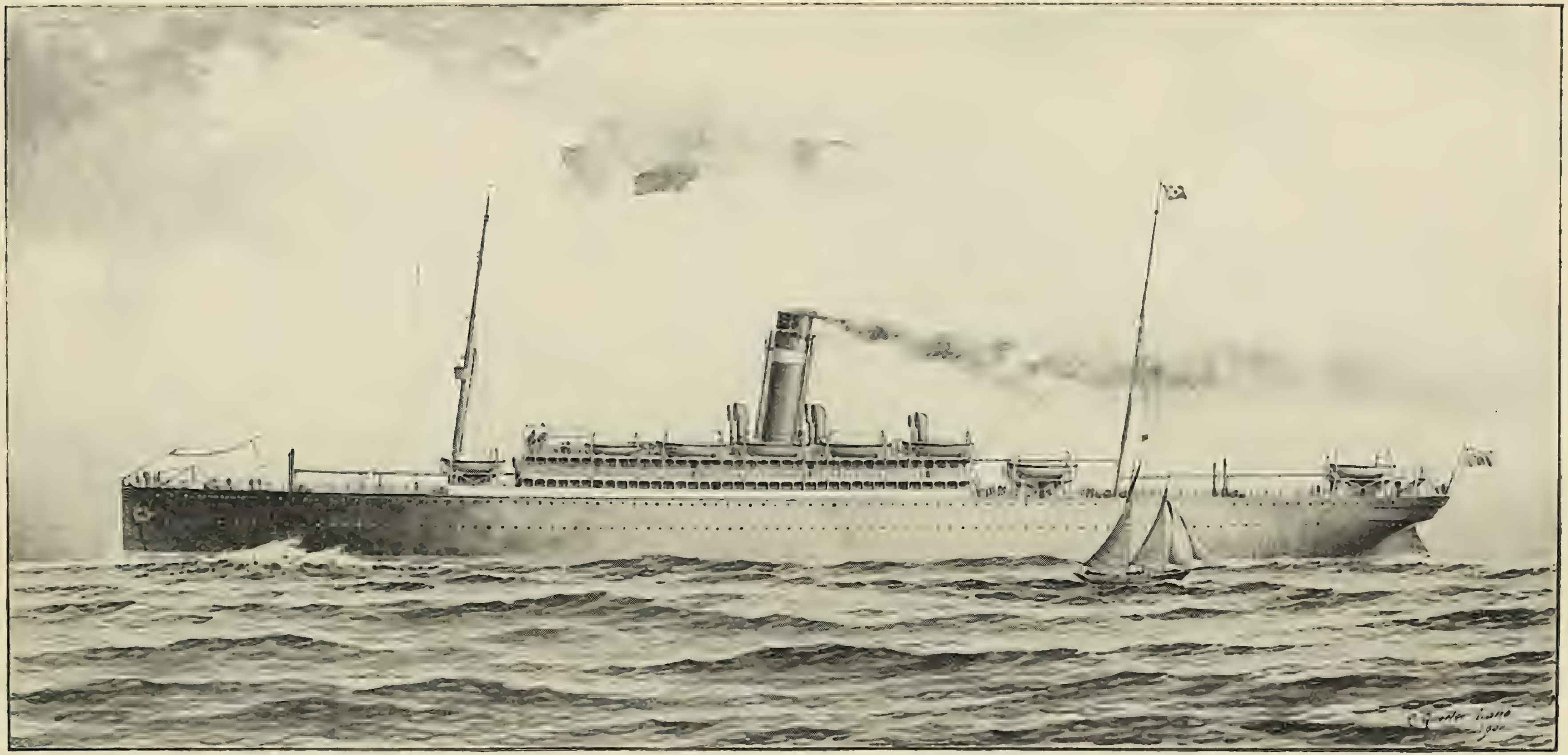
Recently a decision was reached to substitute the electric drive for the present methods in the shops, and plans have been made for the installation of two powerful generating sets in the engine works, and two smaller ones in the shipyard. A pneumatic plant will also be installed, though for the present to a limited extent. Both the yards and the shops are lighted with electric light. In the ship and engine works the average number of employees is 3,500, and for the benefit of these the management conducts a school for apprentices, a hospital, and a water works. Salvage operations are also carried on by the concern. A large plant is now available for wrecking work, and one of the steam vessels now under construction, No. 126, is being built as an addition to the present facilities.

Much of the credit for the forward condition of the dock-yard is due to James S. Clark, the resident naval architect. Mr. Clark has had a wide experience on the Clyde and elsewhere, in both merchant and naval work, and has displayed conspicuous ability in an administrative capacity in his work in Japan.

Transatlantic Liner Commonwealth.

Another fine steamship for the Boston-Liverpool trade has just been put into transatlantic service. This is the T. S. S. *Commonwealth* of the Dominion Line, shown in the accompanying artist's sketch. In general design the new vessel follows the popular *New England* of the same line, though she is of larger dimensions, being nearly 600 ft. long and of 12,000 tons, gross tonnage. She was built at the yard of Harland & Wolff, Belfast, Ireland, and follows their model for transatlantic vessels of the intermediate class.

Although intended to carry an immense amount of freight, the passenger accommodations have not been slighted. The saloon is situated in a deckhouse erected on the hurricane deck, with seating accommodation for about 200, and surmounted by a very elaborate dome skylight in handsome stained glass, with decorated panels. On the saloon deck, which has a large and spacious promenade, easy seats have been arranged for the passengers, and on this deck is the deckhouse containing the handsome entrance to the saloon, lounge and ladies' room, and library, tastefully decorated in polished woods, with bookcase and writing desks. The ladies' room and lounge, as in the *New England*, is fitted immediately forward of the library, and beautifully upholstered in moquette, with stained glass windows into the saloon dome and on to the deck. The majority of the state rooms are in the same house as the saloons, the baths and lavatories being arranged at the after end. On the deck below there is a comfortably arranged second-class



DOMINION LINE T.S.S. COMMONWEALTH, 12,000 G. T., BUILT BY HARLAND & WOLFF AND RECENTLY PUT IN SERVICE BETWEEN BOSTON AND LIVERPOOL, CARRYING PASSENGERS AND FREIGHT.

saloon capable of seating over 100, and on this deck there are also a large number of first and second-class state rooms, together with engineers' quarters, lavatories, pantries, galleys, and other accommodation. On the middle deck there are also state rooms for first-class passengers forward, and second-class passengers aft, arranged conveniently to their respective saloons. Aft in the ship is a well-arranged closed steerage, with large deck accommodation for passengers and also a smoking room on the poop deck. Steerage rooms are arranged on the upper deck in the starboard alleyways. The captain's room and chart room are situated on the boat deck, with pilot house above, and a commodious smoking room has been provided with the door opening on to the saloon deck, and also a stairway to the lower deck for convenience in getting to the cabin accommodation in bad weather. A large smoking room and ladies' room have been arranged for the second-class passengers on the bridge immediately above their saloon.

All modern appliances for the lighting, heating and ventilation of the ship, and for the preservation of perishable cargo and stores have been installed. The propelling machinery consists of two sets of quadruple expansion engines of the builders' usual design.

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WE here present the programme for the eighth general meeting of the Society of Naval Architects and Marine Engineers, which will be held in Engineering headquarters, 12 West Thirty-first street, New York city, on Thursday and Friday, November 15 and 16.

THURSDAY, NOVEMBER 15, 1900.

1. Capacity Test of a Unique Form of Air Pump. By F. Meriam Wheeler, Member.
2. Interchangeability of Units for Marine Work. By W. D. Forbes, Member.
3. The United States Experimental Model Basin. By Naval Constructor D. W. Taylor, U. S. N., Member.
4. The Composition and Classification of Paints and Varnishes. By Prof. A. H. Sabin.
5. Tests of the Electric Plants of the Battleships *Kearsarge* and *Kentucky*. By Naval Constructor J. J. Woodward, U. S. N., Member.
6. Coaling of the U. S. S. *Massachusetts* at Sea. By Spencer Miller, Associate.

FRIDAY, NOVEMBER 16, 1900.

7. Notes on Recent Improvements in Foreign Shipbuilding Plants. By Ass't Naval Constructor H. G. Gillmor, U. S. N., Member.
8. Can the American Shipbuilder under Present Conditions Compete with the British and German Shipbuilders in the Production of the Largest Class of Ocean Passenger and Freight Steamships. By Geo. W. Dickie, Member of the Council.
9. Classification Rules. By Theodore Lucas, Member.
10. Recent Designs of Battleships and Cruisers for the U. S. Navy. By Chief Constructor Philip Hichborn, U. S. N., Vice-President.
11. A Comparison of the Contract Prices of Our Naval Vessels. By Harrison S. Taft, Associate.
12. Launch of a Cruiser and a Battleship. By James Dickie, Member.
13. The Safety of Torpedo-Boats at Sea and in Action Under Various Conditions. By Naval Constructor Lloyd Bankson, U. S. N., Member.

Members who intend to propose candidates for admission to membership in the society can now obtain the necessary forms of application by addressing Secretary-Treasurer Francis T. Bowles at the headquarters. It is desirable that all applications should be in the hands of the secretary not later than Tuesday, November 13, for presentation to the council, which meets on the following day at 3 o'clock in the afternoon.

WHAT is the limit to size and speed of an ocean liner in the transatlantic trade? This is a question that has occasioned much theorizing in times past, and will probably continue to occupy attention so long as the art of steam navigation is practiced. At various times in the past many engineers believed that the question had been settled practically. It would have been settled long ago, had engineering science come to a standstill, and had the commercial possibilities of the age ceased of development. Apparently we are now as far removed from finality as when the old *Alaska* came into port under six days, and held the position among all merchant fleets that the *Deutschland* holds today. However, no sooner have the *Kaiser Wilhelm der Grosse* and the *Deutschland* broken all existing records for ocean going vessels than an announcement of a still larger and faster ship is made. This vessel has been ordered by the North German Lloyd line from the Vulcan Works at Stettin, and she is to be named the *Kron Prinz Wilhelm*. At the same time the same line has ordered from the Vulcan Works, also, another marine monster, which, though not in-

tended to be in the front rank in speed, will be so in point of size and equipment. This vessel, the *Kaiser Wilhelm der Zweite*, will be more than 700 feet long and of proportionate beam and depth, rivaling the now famous *Oceanic* in dimensions. Yet another and larger vessel is to be built for the Hamburg-American line by Harland & Wolff, builders of the *Oceanic*. The new liner will be 750 ft. long and about 76 ft. beam, and will have, according to authoritative statements, a speed of 18 knots. Meanwhile advices from abroad report a stirring up in British shipping circles and the intention, credited to the Cunard line, of making an effort to bring back the speed record to the British flag. In the background, as an unknown quantity is the steam turbine, which may or may not work still greater changes in the transatlantic trade than have been recorded in the past twenty years. This very problem, the application of the turbine to large vessels, is at present absorbing the attention of persons of skill on both sides of the Atlantic. In any event, in this contest for speed, starting from a common point, limitations are reached in the direction of finance more quickly than in the direction of practical engineering. Yet though these limitations are opposite, they have a certain relationship which complicates the question presented to the steamship manager for solution. Given an almost wasteful expenditure from an engineering standpoint, we get an increase in income which, though it may not be proportional to the extra expenditure involved, will be vastly greater than would result from a more moderate investment. Compare the passenger rates of two boats like, for example, the *City of Rome* and the *Deutschland*. One will carry a passenger across the Atlantic just as comfortably as the other—though of course, less luxuriously in the case of the older vessel—and the extra time spent on the water in the case of the smaller vessel is not a matter of real consequence to the average tourist. It is the go-ahead spirit of the time that enters here. Passengers who can afford it, and many who cannot, believe in traveling on the fastest, newest, and most up-to-date ship they can find, and are willing to back up their belief by paying the enormously greater fares. Travelers of this type will always exist in sufficient numbers to fill the sailing list of the record breaker in season. Each of these travelers becomes a missionary for the company, if his expectations are realized, and thus helps to create that sentiment in favor of a line which managers find profitable. And in the case of lines with a reputation to make, it is worth a considerable expenditure to create such a sentiment. There is, to our notion, a more serious limitation than cost, and that is safety. As ships, passenger ships, grow larger, their crews increase in number and the passenger list grows to huge proportions. Yet beyond additions to the number of boats carried, there is no progress in the direction of providing for the safety of those on board in case of extreme peril. Below there may be induced draft and quadruple expansion in the engineer's department, grand pianos and gymnasiums in the passengers' department, but above deck there are the same old boats and davits that hung along the sides in the days when the box boiler was supreme and every cabin passenger was practically his own steward. Water-tight compartments are good "talking points." Something besides compartments, however, was needed on the *Elbe*, *La Bourgogne*, the *Mohegan*, or even on *H. M. S. Victoria*, and that something had no existence in fact. What man of experience at sea would care to contemplate standing on the deck of a modern liner, which was going from under his feet, in company with considerably more than a thousand persons, men, women, and children, in a majority of whom the fierce instinct of self-preservation had taken control. It may be said, truthfully, that a small vessel would sink as quickly as a large one, under like conditions, and that therefore there is no greater danger on the modern monster than on the old liner. It is equally true, however, that the larger the crowd to be handled, the more difficulty there will be in getting results, even though the crew and boats carried are in proportion. Panic is fed by numbers, and every additional passenger is an additional care, not only physically but mentally and morally; an increase of the diversity of opinion and interest that is the antithesis of discipline and co-operation in time of disaster. Disaster cannot be prevented by ignoring its probability. In matters of actual construction vast sums are spent experimentally, but for investigation into the best method of preserving the lives of those carried, not one cent is available. If transatlantic companies can combine to maintain rates, surely they could combine to investigate the subject of the safety of those who pay the rates? They cannot perform their plain duty by waiting until some inventor devises a plan which they can then adopt.

IMPROVED APPARATUS.

Sectional Fire Tube Boiler.

The Cowley & Cooper boiler is designed for use in naval and merchant vessels of large power and under continuous steaming for long periods. By reference to the accompanying drawings it will be seen that the boiler consists of a number of tubular water shells 18 in. dia. and 8 ft. long placed in staggered vertical rows parallel to each other and longitudinally in a slightly inclined position over a furnace. The three shells in each vertical row are joined together at their front and back ends by wrought steel necks, thus forming a unit, as shown in Fig. 1. Each unit is connected at its upper and front end by four 4 in. tubes to a steam drum, which affords separating surface and steam space for the rising currents from each unit. Neck pieces of wrought steel connect each unit at its lower and back end with a mud drum. Two 10 in. downcomers connect the steam drum and the mud drum. A casing covers the entire boiler. Nineteen 2 1-4 in. fire tubes parallel to each other are passed longitudinally entirely through each water shell, their ends being expanded into tube plates which close the corresponding ends of the water shell, as shown in

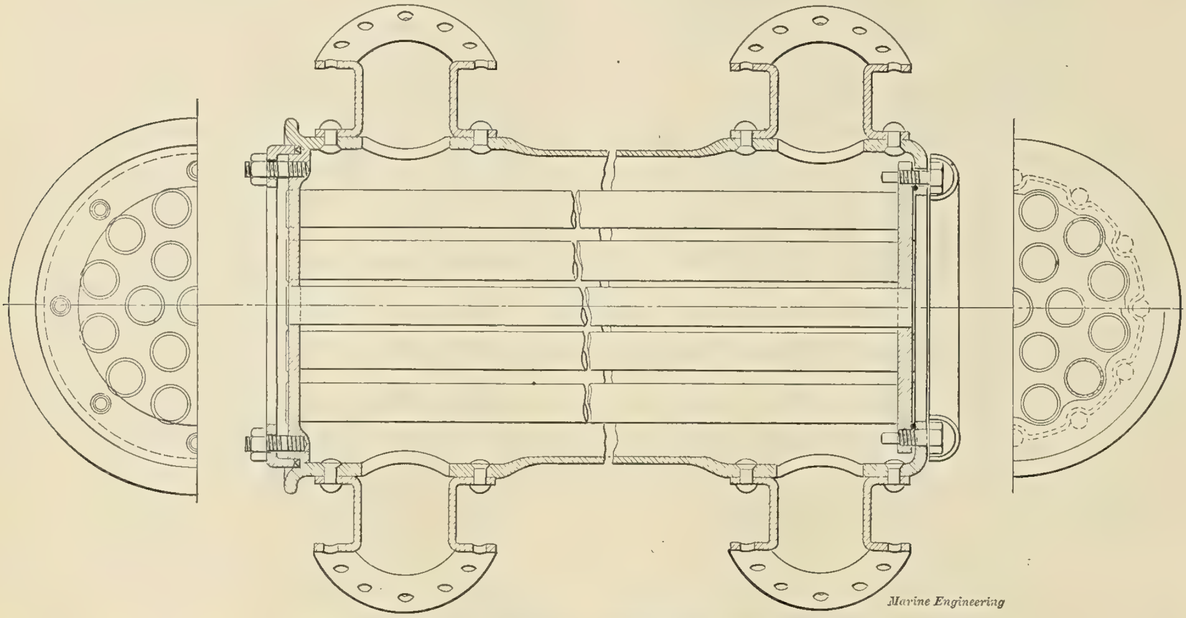


FIG. 1.—UNIT OF COWLEY & COOPER FIRE TUBE BOILER.

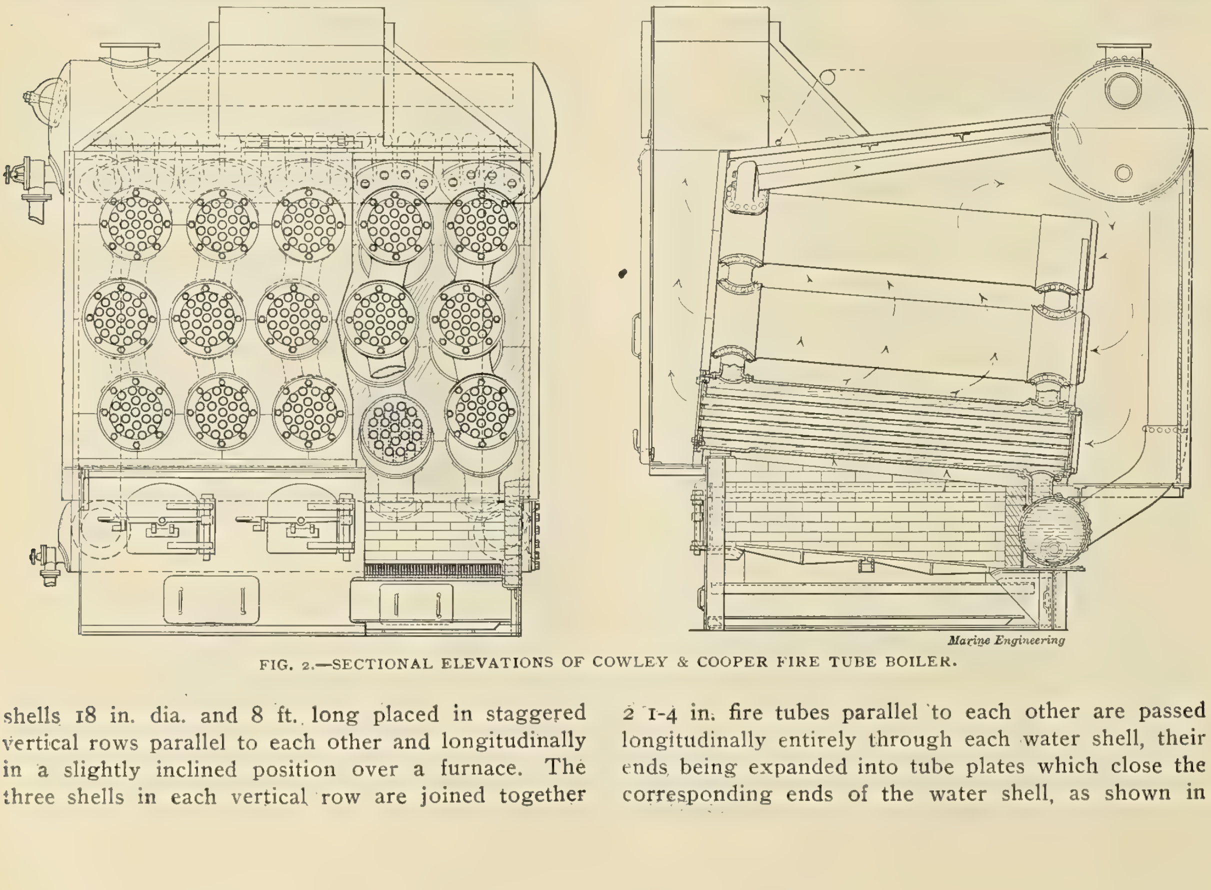
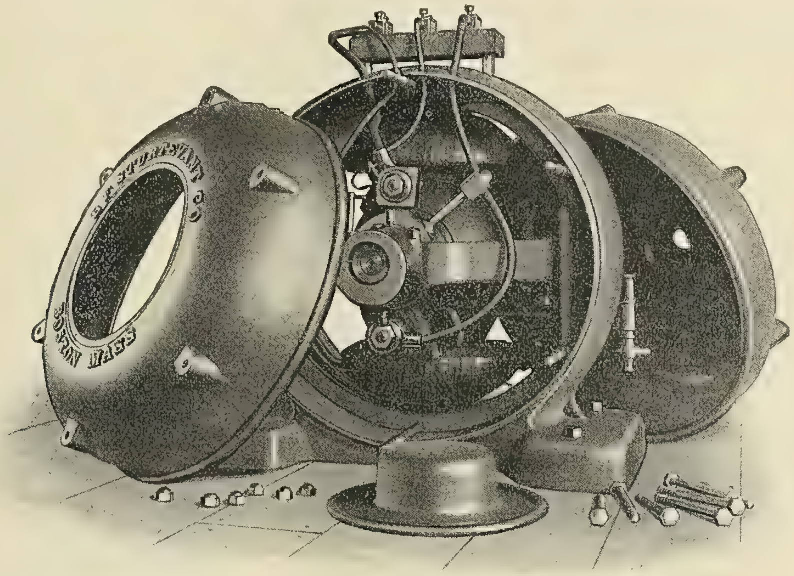


FIG. 2.—SECTIONAL ELEVATIONS OF COWLEY & COOPER FIRE TUBE BOILER.

Fig. 2. Examining one water shell and its contained fire tubes, as shown in Fig. 2, the method of construction is as follows: The back tube plate is small enough to pass through the water shell, the joint between this tube plate and the end of the water shell, which it closes, is made by a round copper gasket. Bolts passing through the flanged end of the water shell are tapped into this tube plate and extend through into the water. By screwing down on these bolts the joint is effected on the copper gasket. A light cast iron guard is placed over the bolt heads to protect them from direct flame and the immersed ends of the bolts carry off the heat. The joint betwen the front tube plate and the water shell is made by a flexible V-shaped metal gasket placed in a recess similar to a stuffing box. A gland of wrought steel is forced down on this gasket to hold it and make the joint. When it is desired to clean the boiler the bolts in the back tube plates are removed and those holding the gland at the front end slackened, and the cluster of fire tubes, together with the tube plates into which they are expanded, are withdrawn from their position in the water shell. By the removal of the fire tubes the water shell is rendered accessible. The baffle casings at the front and back ends of the water shells are made in sections. Room is provided in the design to admit a man between the water shells so that the exterior surfaces may be swept and examined. All the connecting necks are easily cleaned, also the few large water tubes at the upgoing end of the boiler. Ample manholes are provided in the steam and mud drums for examination and cleaning. The heat distribution is as follows: The products of combustion from the furnace pass, as indicated on the drawing by arrows, up and around the water shells, thence into the combustion chamber formed by the casing and steam drum, and finally through the fire tubes to the uptake and stack. The radiant heat from the furnace is taken up by the water shells. An auxiliary draft door is provided, as shown at *A* in Fig. 1, and by opening this the gases are passed directly into the stack when first starting fires, also leaving the fire tubes free for examination, plugging, etc., and also reducing the rate of steaming. It has been the purpose to design a marine type of sectional fire tube boiler to carry very high pressures, to contain a sufficient volume of water and weight much less than the cylindrical or Scotch boilers in use. The fire tube type has been adopted because of the mechanical advantages of small tubes under external pressure, and because of the practical advantages in handling fire tube boilers at sea. The boiler consists of numerous small tubular boilers gathered together in one casing and all connected so as to discharge their steam into one steam drum. The cluster of fire tubes in each small boiler is made removable that both may be cleaned. The construction is entirely of wrought steel and the boiler can be built for high pressures without excessive weight of material. The units, or sections, of which the boiler is composed may be passed through the hatch of a ship and erected in place. The address of the designers is Everett, Mass.

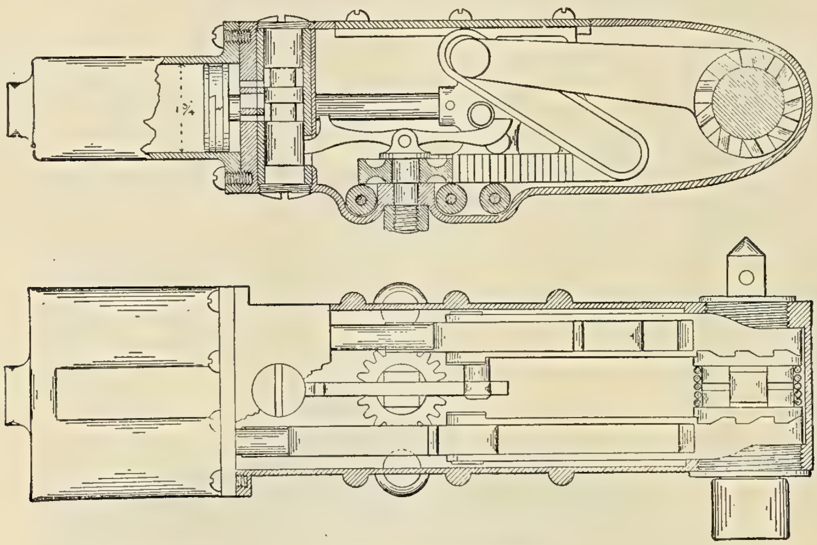


STURTEVANT ENCLOSED ELECTRIC MOTOR.

Enclosed Electric Motor.

The bi-polar type of enclosed motor, the internal construction of which is illustrated in the accompanying engraving, is manufactured both as a motor directly connected to a propeller fan and as an independent machine. For the former purpose it is used on all sizes of fans up to and including the 54 in. For larger sizes the four and eight-pole types are employed. The motor is entirely enclosed, and thereby protected from dust, an important element in a machine used under these conditions. In order to avoid the excessive temperature which is incident to the operation of many enclosed motors, this type has been very carefully designed, so that a low temperature rise can be maintained without greatly increasing the size and weight above that of the ordinary open type. This machine is capable of continuous opera-

tion for ten hours, with a maximum temperature rise not exceeding 60 deg. F. Yokes extending out from the field ring support the armature shaft. The end casings are entirely independent and can be instantly removed to give access to the entire interior. The

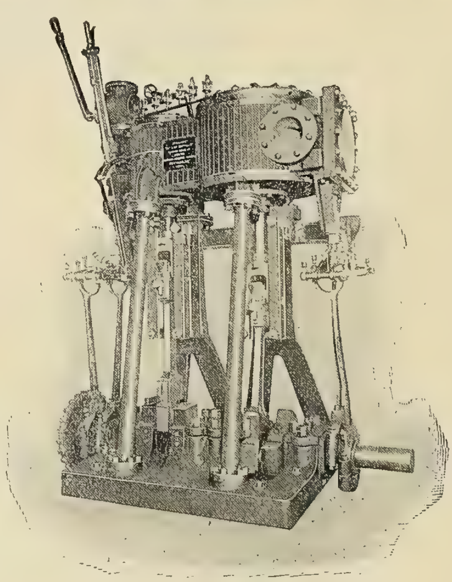


U. & W. PISTON AIR DRILL.

bearings and brushes can be reached by simply removing the caps in the center of the casings. The brushes are of hard carbon, in holders of a modified reaction type, which allows of easy adjustment when it becomes necessary to reverse the direction of rotation of the motor. The bearings are self-oiling and self-aligning, and fitted with composition sleeves, which are removable from the outer ends of the boxes. These motors, in sizes from 1-6 to 5 H. P., are built by the B. F. Sturtevant Co., Boston, Mass.

Piston Air Drill.

Among the late additions to the now long list of pneumatic devices is the U. & W. Piston Air Drill, manufactured by the Columbus Pneumatic Tool Co., Columbus, Ohio, an engraving of which is here presented. This drill has been designed with especial reference to work in close quarters where considerable power is necessary. The movement of the shaft is secured by a simple ratchet mechanism, consisting of two clutches and two arms. The arms are free to move about, but are prevented from moving along the shaft. The clutches are free to move along the shaft a distance of 3-32 in., but engage lugs on the shaft which communicate the rotary motion from the clutches to the shaft. The outer end of the arm engages the slot in the crosshead, and as the piston forces the crosshead back and forward, the arm moves up and down and about the shaft. On the forward stroke, the teeth on the arm engage those on the clutch and the shaft is rotated, but on the back stroke the clutch is forced out of engagement, and, slipping along the shaft, allows the arm to move freely about the shaft. It will be seen that, there being two arms which move in opposite direction, at the same time, the shaft is rotated continuously. At the base of each crosshead there is a rack, and between these racks a gear operates. The function of the gear is to transmit the power developed on the return stroke of the piston to the crosshead which is moving forward, thus delivering the power of both cylinders to the arm that is, at the time, rotating the shaft. The valve motion consists of a shifter and two piston valves, one inside the other. The inner or auxiliary valve is employed to set the main valve and derives its motion from the shifter which is operated by a pin extending from one of the crossheads. A forward movement of the crosshead



BELL MARINE ENGINE.

forces the shifter down, thus raising the valve; an opposite movement of the crosshead effecting the lowering of the valve. The main valve is set by live air properly distributed by the auxiliary. This simple shaft mechanism allows of small dimensions, it being

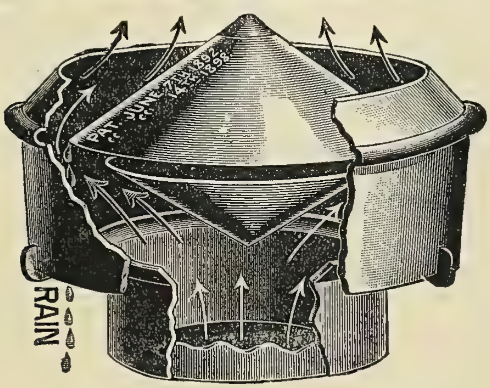
only 1 1-8 in. from the center of the shaft to the outer edge of the casing, and since the axis of the shaft coincides with the axis of the drill used, holes can be drilled, the centers of which are the above distance from a corner or flange. Its simplicity makes it easily cared for and makes repairs infrequent, and its light weight enables it to be easily handled by one man.

Vertical Marine Engine.

In the engraving on page 482 there is shown a fore and aft engine recently built by the Bell's Steam Engine Works of Buffalo, N. Y., for use in a fast steamer on Chautauqua Lake, N. Y. The engine was designed and built for a steam pressure of 250 lb. The cylinders are 12 in. and 26 in. dia. by 14 in. stroke and the bed plate is of the regular box type, with facing pieces to receive the front and back columns. The crank shaft is of forged steel 6 in. dia. The cylinders are supported at the back by cast iron columns. The crossheads are of open hearth cast steel with brass boxes in the connecting rods. In the front the cylinders are supported by wrought iron polished columns. The cranks are set at right angles to each other and the cylinders are provided with receivers in connection with the belt around them, which gives an effective steam jacket. The high pressure has a single piston valve and the low pressure cylinder is provided with an ordinary slide valve, both valves being operated by a Stephenson link of the double bar type. Piston and connecting rods are of forged steel, and the throttle is of the balanced type. The design of the engines was very carefully worked out on a basis of 600-700 ft. piston speed per minute, and great care was also taken to have all the reciprocating parts accurately balanced to avoid jar. The engine is of about 200 horse power.

Pancoast Marine Ventilator.

In the accompanying engraving is shown a section of a Pancoast ventilator manufactured by the National Pancoast Ventilator Co. of Philadelphia, Pa., for use on vessels and for buildings ashore. This

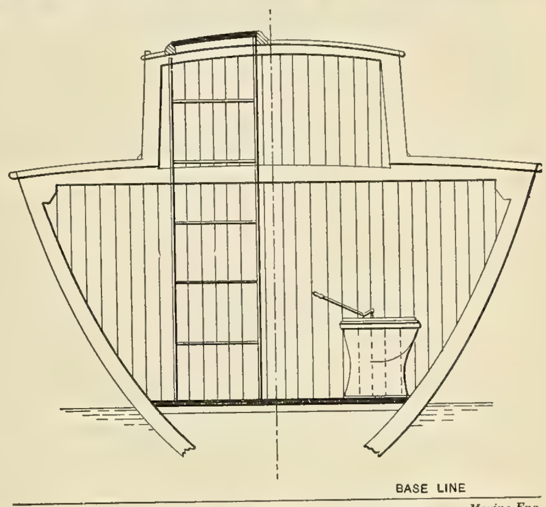


PANCOAST VENTILATOR.

ventilator is designed to be storm proof and it is especially adapted for use as an exhaust ventilator; in many instances on ships this form of ventilator being used for exhaust and the ordinary cowl used for intake.

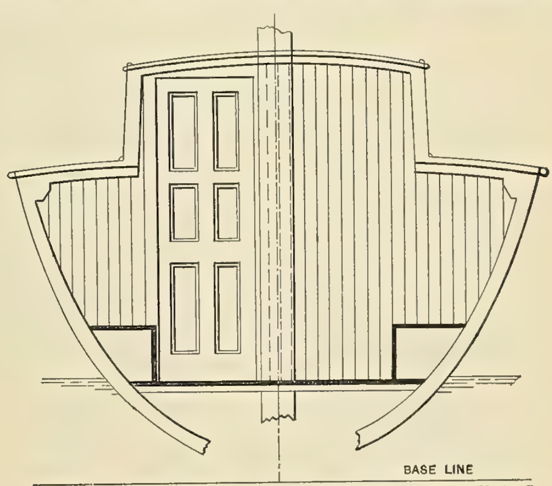
Auxiliary Hunting Yacht.

In the accompanying plans there is shown an auxiliary yacht built recently by the Gas Engine & Power Co. and Charles L. Seabury & Co., Con., for the special purpose of cruising in shallow waters on



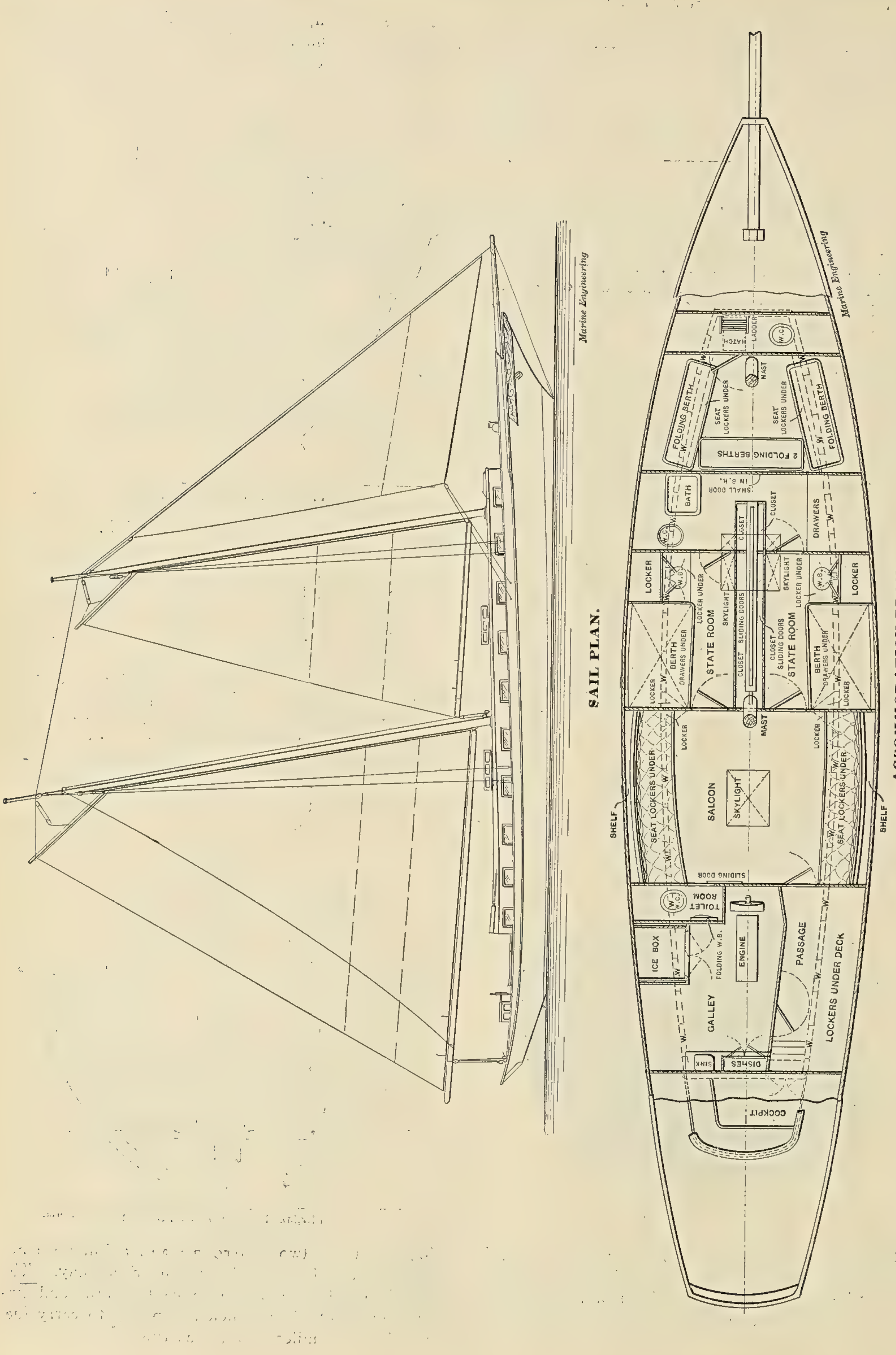
FRAME 9. LOOKING FORWARD

hunting expeditions. The yacht is 68 ft. long over all and 15 ft. beam. The house extends to nearly the full length of the cockpit, giving all the inside accommodations possible, and by reason of the extreme light draft, which does not exceed 32 in. with full load, the freeboard is unusually high. The rig has been cut down for easy handling by a small crew, and the yacht has plain pole masts. The power plant is large in comparison with the equipment of most auxiliary craft, and it is the intention of the owner to use this quite extensively—probably more than the sail. The engine is of the builders' naphtha type, with three cylinders, and is rated at 24 horse power. It drives a 28 in. two bladed propeller of high pitch. Polished red mahogany is used for furnishing the



FRAME 11. LOOKING FORWARD

saloon, and the two staterooms and adjoining compartments are finished in white mahogany. The yacht is fitted with a bronze centerboard, and has copper tanks fitted of sufficient capacity to carry fuel for a thousand miles continuous run.



SAIL AND ACCOMMODATION PLANS OF AUXILIARY HUNTING YACHT, BUILT AND EQUIPPED BY THE GAS ENGINE & POWER CO. AND CHARLES L. SEABURY & CO., CONS.

ACTION OF BILGE KEELS FROM A HYDRODYNAMICAL POINT OF VIEW.—II.*

BY G. H. BRYAN, F. R. S.

II.—EFFECT OF STREAM-LINE MOTIONS.

(6) When a cylinder of other than circular section is rotating in fluid, whether the rotational motion be steady or oscillatory, stream-line motions are set up, the effect of which is to cause the fluid to flow past the more protruding portions of the cylinder in the opposite direction to that in which the cylinder is turning. If a small lamina or paddle be fixed projecting from the cylinder where it can intercept this counter current, the increased relative velocity of the fluid increases the pressure on the lamina, which we shall assume to vary as the square of the relative velocity.

In the case of an elliptic cylinder whose longest and shortest diameters are in the ratio of 3 to 2, this stream-line motion would almost exactly double the pressure on a small lamina projecting from the extremity of the longest diameter.

For cylinders of section other than elliptical, the increase of pressure due to this cause depends, however, quite as much on the form of the section as on the ratio of its greatest and least radii, and it may be laid down as a general rule that, when the protruding parts are smoothly rounded, the stream velocity is small, while sharp bends produce a considerable increase in the stream velocity, until, when the two sides actually meet at an angle projecting into the fluid, the stream velocity becomes infinite at the angle, and the stream-line motion is replaced by discontinuous motion.

(7) The problem of the stream-line motions past cylinders of given section is, in general, very difficult of solution; but, by taking suitable forms for the stream function, we can obtain solutions for cylinders whose curve of section coincides with a given contour at any number of assigned points. In this way the stream-line motion could theoretically be worked out for a cylinder of section approaching to the midship section of a given ship to any degree of approximation. The calculation, however, becomes very complicated, if the section approximates to a highly angular form.

In the small time available for the preparation of this paper, it has only been possible to work out a few simple cases. The points by which the shape of the contour lines have been determined are shown in the figures; the intermediate form of the curves is merely roughly sketched in, and is not to be regarded as accurate.

For the section shown in Fig. 1, the pressure at A_2 is increased by about 35.7 per cent., although the longest radius only exceeds the shortest by about 13 per cent. It is to be noted that the points A_3, A_4, A_5 lie in a straight line.

Fig. 2 shows a section of rather theoretical interest, in which the increase of pressure at A_2 amounts to 46.85, say, 47 per cent. That only a difference of 11 per cent. exists between the cases represented in Figs. 2 and 3 is due to the fact that the convex parts of both curves are very smoothly rounded, and the difference of form chiefly lies in the presence of re-entrant corners in Fig. 2, which are much less ef-

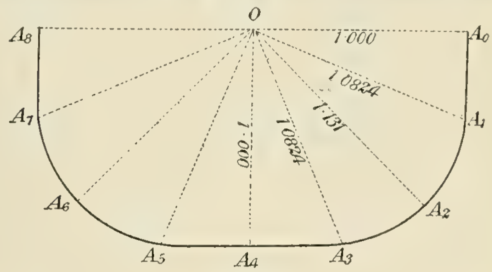


FIG. 1.

fective than protruding angles in modifying the pressures at the protuberant parts.

In Fig. 3 we have a nearer approximation to a square section, the points A_0, A_1, A_2, as also the points A_4, A_5, A_6, A_7, A_8, being in a straight line. In this case the stream-line motion increases the pressure at A_3 and A_9 by 67 per cent.

These results represent what happens when the moving body is a complete cylinder, symmetrical

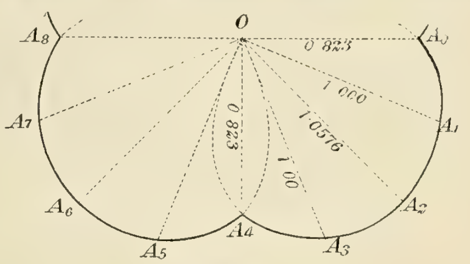


FIG. 2.

about O, rotating in an infinite mass of fluid. In addition to the stream motion producing counter-currents round the salient parts of the cylinder, it causes the fluid to move in the same direction as the cylin-

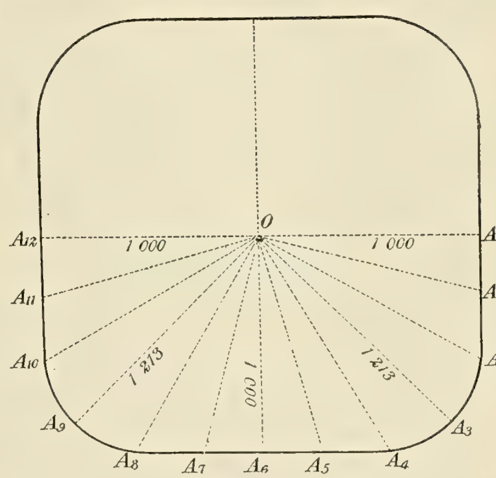


FIG. 3.

der at the points nearest the axis, such as A_0. If we suppose the fluid, instead of covering the cylinders, to reach only half way up them, Figs. 1 and 3 give a fair *general* representation of the midship section of

*Read before the Institution of Naval Architects, London.

many ships floating in water. From what we have just said, the motions which were investigated in obtaining the above results cause the surface of the water to rise and fall with the ship, an action opposed by gravity. So far as gravity is effectual in directly counteracting these variations of the water level, the result is to superpose counter-currents, which tend further to increase the effective pressure at the protuberant parts. If we suppose the velocity of stream-line motion to be doubled by these added counter-currents the increase of pressure will be more than doubled. It is, therefore, not improbable that in a ship of section similar to Fig. 3, the efficacy of bilge keels fitted at A_8 and A_9 may be more than double that of a paddle oscillating freely in water. As a matter of fact, however, the action of gravity produces waves and throws the calculations beyond the domain of exact mathematical analysis.

(8) To test this point further, I adopted a different form of stream function, chosen so as to make the vertical velocity zero at the surface of a horizontal plane. This represents what would be the stream-line motion, if a ship were rolling in water covered with a hard and perfectly rigid sheet of ice, supposing this ice just to allow the vessel free play to roll.

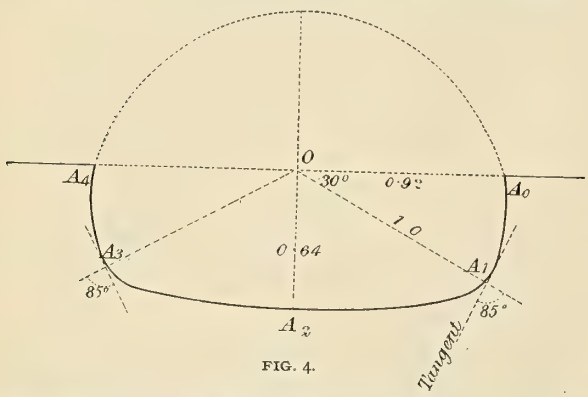


FIG. 4.

The form chosen for the contour of the section (Fig. 4) roughly is somewhat like the midship section of the *Revenge* given in Sir. William White's paper, but with rather lighter draught than any there indicated, the modification being made to make the calculation easier. In this case it was found that the effective pressure at A_1 and A_3 was just over double—2.085 times that due to the rotational motion of the ship alone. At points rather lower down the effective pressures would be somewhat greater.

The assumed surface condition at the horizontal plane A_0 O A_4 can be produced, even if the fluid be indefinitely extended above the horizontal plane, by supposing the cylinder completed, its section in the upper portions being of the form roughly sketched out in Fig. 4, the equation of the curve of section being the same as for the submerged portion and its form being thus completely determinate.

These are but rough examples, but they may serve to show the general effect of the shape of the ship in modifying the resistances on bilge keels, and the importance of placing the keels in such a position as to encounter the strongest possible counter-currents past the sides of the ship.

LAUNCHES—HOME AND FOREIGN.

Torpedo Boat Bagley.—The torpedo boat *Bagley* was launched at the yard of the Bath Iron Works, Bath, Me., recently. The vessel, which was named for the late Ensign Worth Bagley, was christened by a sister of the deceased officer, Mrs. J. Daniels. The boat is of these dimensions: Length between perpendiculars, 157 ft.; beam moulded, 17 ft.; depth at center, amidships, 10 ft. 9 in.; displacement, 160 tons. Her contract calls for a speed on trial of 28 knots. Her armament consists of 3-pdrs. and three tubes for 18 in. short Whitehead torpedoes, of which there is provision for carrying five. There is a conning tower forward made of 1-2 in. nickel steel. The propelling machinery consists of two vertical triple expansion engines, and two water tube boilers, each in separate water-tight compartments, separated by transverse bulkheads.

Torpedo Boat O'Brien. — The torpedo boat *O'Brien* was launched at the yard of Lewis Nixon, Elizabethport, N. J., on September 24. The boat was christened by Miss Mira L. O'Brien, a direct descendant of Joseph O'Brien, one of the five brothers who captured the *Margaretta* off the coast of Maine on May 11, 1775. The *O'Brien* is of the following dimensions: Length on load water line, 174 ft. 6 in.; extreme beam, 17 ft.; mean draft, 4 ft. 6 in.; displacement, 174 tons; gross tonnage, 217.52 tons, and a speed of 26 knots. She is fitted with twin screw vertical quadruple expansion engines. Her armament consists of three 3-pdrs. R. F. and three 18 in. Whitehead torpedo tubes.

Torpedo Boat Decatur.—The torpedo boat *Decatur* was launched at the yard of the William R. Trigg Company, Richmond, Va., recently. The vessel is of the following dimensions: Length on load water line, 245 ft.; extreme beam, 23 ft. 7 1-4 in.; mean draft, 6 ft. 6 in.; displacement, 420 tons; gross tonnage, 515.13 tons, and a speed of 28 knots. She is fitted with twin screw vertical inverted triple expansion engines. The *Decatur* was christened by Miss Maria Ten Eyck Decatur Mayo, of Norfolk, Va., who is a direct descendant of Commodore Stephen Decatur, after whom the vessel was named.

Sch. Edith H. Symington.—The schooner *Edith H. Symington* was launched at the yard of W. S. Currier & Co., Newburyport, Mass., recently. The vessel was christened by Miss Grace H. Currier, who scattered a bunch of white roses over the bow, instead of the usual custom of breaking a bottle of champagne. The *Edith H. Symington* is of these dimensions: Length, 173 ft. 1 in.; beam, 39 ft.; depth of hold, 18 ft. 6 in., and carrying capacity, 1,500 tons. Her managing owner and master is Captain Frank D. Stiles, of Keyport, N. J.

Sch. Edward Stotesbury.—The four masted schooner *Edward Stotesbury* was launched at the yard of McKay & Dix, Bucksport, Me., on October 11. She is of these dimensions: Length, 210 ft.; beam, 41.6 ft.; depth of hold, 21.6 ft.; gross tonnage, 1,446 tons. She is designed for the general carrying trade. Charles B. Dix, of New York, is managing owner.

Russian Battleship Retvizan.—The Russian battleship *Retvizan* was launched at the yard of the William Cramp Ship and Engine Building Co., Philadelphia, on Oct. 23. She was christened by the Rector of the Russian Orthodox Church of New York. The new battleship is the largest ever built in this country, and her total cost will be about $3,000,000. She is of these dimensions: Length between perpendiculars, 376 ft.; beam, 72 ft. 2 1-2 in.; displacement, 12,700 tons, and a speed of 18 knots. Her batteries will consist of four 12-in., twelve 6-in., twenty 3-in. guns, and six torpedo tubes. The main belt of armor is 9 in. thick. Her protective deck has a thickness of 4 in. on the slopes and 2 in. on the horizontal portion. Arrangements have been made for insuring a continuous supply of ammunition to the rapid firing guns. The turrets are to be operated by electricity. Many of the auxiliary machines which are usually worked by steam will be operated by electricity.

Freight Steamer Asuncion.—The freight steamer *Asuncion* was launched at the Lorain (Ohio) shipyard of the American Shipbuilding Co. recently. She is a sister ship to the *Paraguay*, which was launched a short time before. The *Asuncion* is of these dimensions: Length over all, 256 ft.; length of keel, 242 ft.; beam moulded, 42 ft.; depth moulded, 26 ft. 6 in. She is fitted with quadruple expansion engines, with cylinders 15 in., 23 in., 35 in. and 54 in. dia. and 36 in. stroke. Steam will be supplied by two Babcock & Wilcox boilers. These two vessels were designed for the seaboard trade, and are owned by the International Steamship Co., of which A. B. Wolvin, of Duluth, is manager.

Sch. Eleanor A. Percy.—The six masted schooner *Eleanor A. Percy* was launched at the yard of Percy & Small, Bath, Me. She is the largest vessel of her class ever built and is of the following dimensions: Length, 323.5 ft.; beam, 50 ft.; depth, 24.8 ft.; gross tonnage, 3,401.96 tons. The frame of the vessel is of hackmatack, and her hull is strengthened by steel braces. Her decks are of hard pine and her cabin fittings of quartered oak and mahogany.

S. Y. Genesee.—The yacht *Genesee* was launched at the yard of Lewis Nixon, Elizabethport, N. J., on October 13. She is an auxiliary schooner designed by Cary Smith & Barbey, and is of the following dimensions: Length over all, 148 ft.; length on water line, 110 ft.; beam, 27 ft.; depth, 16 1-2 ft. The *Genesee* is building for James S. Watson, of Rochester, N. Y.

The Norwegian steamer *Veritas* came into collision with the Leyland line steamer *Devonia* from Boston in the Mersey on October 13. Unsuccessful attempts were made to beach the *Veritas*, but it became necessary to tow her over to the Liverpool side. The cable then parted and she came into collision with the steamer *Earl of Powys* and caused the latter to break from her moorings. Both steamers drifted down the river, and the *Veritas* crashed into two heavy iron booms, stretched from the pierhead at St. George's landing, carrying away everything above her deck and leaving her a submerged wreck. While drifting the *Earl of Powys* smashed her boats and lost her propeller. All of her crew managed to get to the dock wall.

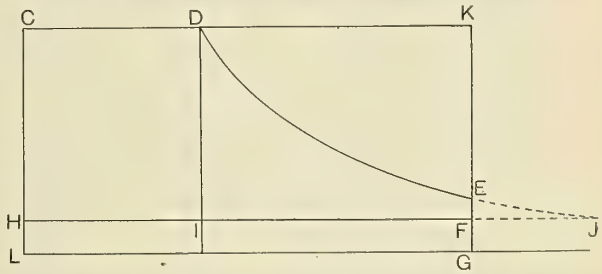
THE MARINE STEAM ENGINE.

AN ELEMENTARY DISCUSSION OF THE PRINCIPLES WHICH GOVERN THE ECONOMICAL USE OF STEAM FOR THE DEVELOPMENT OF POWER—II.

BY DR. WILLIAM FREDERICK DURAND.

In the last issue the general conditions which affect the question of steam engine economy were discussed. Among other points the cycle of the ideal engine was described and it was pointed out that the more nearly the cycle of the actual engine approaches that of the ideal, the better its efficiency. The question of the *expansion of steam* and its influence on engine economy has long held an important place as perhaps the chief factor in engine economy, and it may therefore be well to refer to this feature in somewhat further detail. From the standpoint of the discussion in the last issue, we should say that the expansion of steam is favorable to economy because it brings the cycle of operations nearer to that for the ideal engine. These points may, however, be treated in a more elementary manner as in the present issue, and we therefore proceed to discuss the question by the actual comparison of the two indicator diagrams given by an engine working with and without expansion.

Consider the two cards $C\ D\ I\ H$ and $C\ D\ E\ F\ H$. The first is the card that would be given by using the



steam in an engine with stroke $C\ D$ following to the extreme end, and then exhausting along $D\ I\ H$. The second card is such as would be given by the same steam used expansively cut-off taking place at D and the stroke continuing expansively to E. The back pressure in each case is represented by the line $H\ F$. The area $C\ D\ I\ H$ represents the work in one case and the area $C\ D\ E\ F\ H$ in the other, so that the difference or $D\ E\ F\ I$ represents the gain by expansive working. In other words, if we use the steam full pressure up to D and then exhaust it, we throw away an amount of work measured $D\ E\ F\ I$ which might be saved by expansive working. It is likewise true that the exhaust opening at E causes a loss of work $E\ J\ F$ which might be saved by continuing the expansion down until the forward pressure falls to the back pressure as at J. It is rare, however, that we can afford cylinders of sufficient size to carry the expansion to such a point, and, as may be seen, the amount thus lost is smaller and smaller as the final pressure $E\ G$ is nearer the back pressure $F\ G$.

To illustrate the gain by expansive working let us suppose the initial pressure $L\ C$ = 100 lb., the back pressure $L\ H$ = 3 lb., and that the cut off is at a

series of points .1 .2 .3, etc. Then neglecting the effect due to clearance, the number of expansions will be as 10, 5, 33, etc., and the ratio of saving will be as given in the following table. The numbers in the column headed *e* give values of the ratio $D\ E\ F\ I \div C\ D\ I\ H$, or the ratio of the amount saved by expansion to the amount done before expansion begins.

Point of Cut-off.	Expansion Ratio.	*e*.
.1	10.	2.11
.2	5.	1.55
.3	3.30	1.18
.4	2.50	.91
.5	2.00	.69
.6	1.66	.51
.7	1.43	.36
.8	1.25	.23
.9	1.11	.11
.10	1.00	.00

It will be understood that the figures of the above table refer to indicator cards such as those of the diagram in which there is no allowance for clearance, compression, rounding off of corners, etc. These conditions are of course taken in order to simplify the necessary computations. The nature of the results would, however, be the same in the actual case, and these figures may therefore be taken as sufficiently close indication for illustrative purposes.

It thus appears that the gain is proportionately greater the larger the number of expansions, and for the highest efficiency we should therefore carry the expansion to the highest limit. Practically there are two considerations which fix an early limit to this extension of the expansion range. The first is the limit of size. The greater the number of expansions the larger the engine and hence, especially for marine engines, we can seldom afford weight enough to give the number of expansions which other considerations might warrant. The second limitation comes from the increase of internal or cylinder condensation which increases with the number of expansions until finally the resulting waste would off-set the gain due to the increase in ideal efficiency.

This loss is decreased by the compounding of engines, so called, or by the splitting up of the total expansion into a series of steps in separate cylinders, as explained last month. Hence with multiple expansion engines we are able to employ higher rates of expansion without corresponding losses from cylinder condensation than with a single cylinder; and this is the real significance of the use of multiple expansion rather than simple engines.

Economy of the Actual Engine.—We have already seen that the highest possible efficiency of an ideal engine under usual conditions will be found between 25 and 30 per cent, while the actual engine at the best will realize only some 60 or 70 per cent of these figures, or an efficiency of say 15 to 20 per cent in good practice. Now one horse power is 33,000 ft. lbs. of work per minute, and from the value of the work equivalent of heat this is equal to $33{,}000 \div 778 = 42.42$ heat units per mt. Hence one horse power means the transformation of 42.42 heat units per mt. into mechanical work. It follows that the heat which must be supplied to the engine in order to provide for one horse power will be given by dividing this number 42.42 by the efficiency at which the transformation is effected. But $42.42 \div 15 = 283.+$ and $42.42 \div 20 = 212.+$. Hence, placing the limits a little more broadly, it appears that in good practice we shall require from say 200 to 300 heat units per mt. for each horse power developed in the engine. This corresponds to a range of 12,000 to 18,000 heat units per hour. Now remembering that each pound of steam brings to the engine roughly 1,000 heat units, it is clear that this will correspond to a range of steam consumption of say 12 to 18 lb. per I. H. P. per hour. These figures may be taken as covering the range of good practice from about the best at present attainable to a value only moderately fair for modern triple expansion engines, or very good for the usual type of compounds.

Again each pound of coal burned may be expected to furnish under good conditions some 9,000 or 10,000 heat units to the water in the boiler, or to transform some 9 or 10 lb. of water into steam. Hence the coal required per I. H. P. per hour will be given by dividing the heat units or the lbs. of steam required by the amount of either which may be expected from one pound of coal. This will give a coal consumption of from about 1.2 to 1.8 lb. per I. H. P. per hour which may also be considered as representing the upper part of the range of good practice for triple and quadruple expansion engines under from moderately good to the very best conditions at present attainable.

For compound and simple condensing engines under good to moderate conditions the steam consumption will rise to from 20 to 30 lb. of steam, corresponding roughly to from 2 to 3 lb. of coal with good boiler economy, and to perhaps 2.5 to 3.5 lb. with poor boiler economy.

Farther along the line will come engines perhaps non-condensing, and of still lower efficiency, such for example as electric light, centrifugal pump, blower, winch, and steering engines. The steam required for them may rise to from 40 to 60 lb. or more per I. H. P. per hour, corresponding to a coal consumption of from perhaps 4 to 8 lb. according to the boiler efficiency.

Still lower in the scale of economy we find the ordinary direct acting pump. Such pumps operate in the steam cylinder with almost no steam expansion, and the piston speed is very low, thus giving full time for the transfers of heat which cause cylinder condensation. Due to these and other less important causes the steam consumption may rise to 200 lb. and more per I. H. P. per hour, while rarely can it be brought as low as 100 lb. This corresponds to a coal consumption from say 10 to 25 lb. depending somewhat on the efficiency of the boiler. In terms of absolute efficiency these figures correspond to from about 1 to 3 per cent, the values thus ranging downward from 15 to 20 per cent given above as the highest values at present attainable.

The submarine boat *Holland* has been placed in commission, and will be sent to the Naval Academy for practice work by the naval cadets.

PRACTICAL TRIAL OF LIQUID FUEL IN THE BOILERS OF S.S. COWRIE.

The oil tank steamer *Cowrie*, of the Shell Transportation and Trading Co., Ltd., of London (Messrs. M. Samuel & Co., managers), has recently arrived at the Standard Oil Company's wharves at Bayonne, N. J., in New York Harbor. The vessel is of 4,893 gross tons, and has a displacement of 6,900 tons at the load-water line. She was built by Armstrong & Mitchell, Newcastle-on-Tyne, England, in 1896. Her equipment is similar to other vessels of her class, as she is fitted with a triple expansion engine and three large single-ended Scotch boilers.

The Shell Transportation Co. has a large oil supply at its concession in the Koetei district, Borneo, covering 100 square miles, and on which work has recently been begun. The residue of the refining of this oil amounts to about half of the quantity exported, and the company proposes to sell this residue for liquid fuel. The crude oil itself can also be used for liquid fuel, while the refined oil is used in the manufacture of gas.

The *Cowrie* left the Tyne for Bombay on her last trip using coal as fuel. After her cargo was discharged at that port the oil burners were fitted, and she proceeded to the port of Balik Pappan, in the Koetei district of Borneo. From there she returned to London, stopping at Colombo, Suez and Port Said, and from London she sailed to New York.

There have been no radical changes made in order to adapt the power plant to the new system. The 800 tons of liquid fuel is carried in the cofferdams in the forepeak, which were originally intended for water ballast. In the bunkers a space holding about 30 tons, and situated several feet above the tops of the boilers, has been made tight, and this tank feeds the oil burners by gravity, and is pumped full about once a day. The donkey boiler is also fitted with burners, and has a small gravity tank fitted above it.

The oil burners are of the Flannery-Boyd type, and are very simple in construction. To install these burners the grate bars, bearers and bridge walls were removed from the furnaces. A hole about 4 1-2 in. dia. was made in the fire doors and door liners, and the burners, which are shaped like a conical projectile about 3 in. dia., are placed in the center of these holes, the point of each projecting slightly beyond the door liner. Steam is used for spraying the oil, and the conical end of each burner has two annular openings, the size of which may be increased or decreased at will by screw-handles at the back of the burner. The outer opening connects with the steam, and the inner opening connects with the oil supply. The steam pipes are connected to the auxiliary steam line by a reducing valve, which maintains a pressure of 80 lb., and these, with the oil pipes, are run under the smoke boxes to fixtures on the furnace fronts, on the sides opposite the fire door hinges. From the fixtures the steam and oil pipes lead to the burner, one entering it from above and the other below, each having a plug-cock connection at the fixture so that the burner may be withdrawn from the opening in the fire door and swung off to one side as if it were on hinges, swinging opposite to the fire door hinges. By this means the door can be opened at any time and the furnaces examined.

The ash pits are fitted with plate doors and notched quadrants, so that the amount of air can be regulated

It has been found impracticable to blow such a flame directly into the bare furnace, as the riveted seams at the furnace throat and combustion chamber would suffer, and the products of combustion would go through the boiler so quickly that there would not be enough heat absorbed, and a high funnel temperature would be the result. This difficulty has been obviated by fitting the furnace with fire-brick baffles. In the first place, the furnaces, which were of the Purves ribbed type, were laid with one course of fire-brick in a semicircle down from the center, leaving the crown of the furnace exposed. The sides and backs of the combustion chambers were likewise bricked up to the level of the bottom row of tubes. The first baffle is placed across the middle of the furnace, and consists of a cross of fire-brick, one leg horizontal and one vertical, and each about 10 in. square. The second baffle is built in the throat of the furnace, half in the furnace and half in the combusion chamber. It is a fire-brick wall in which the bricks were placed slightly apart, leaving a series of openings about 3 in. by 4 in., giving the appearance of pigeon holes. The flame from the burner impinges on the center of the cross-shaped baffle and is deflected, striking all around the sides, and slightly backwards. The second baffle at the throat still further retards the gas, and distributes it uniformly in the combustion chamber. It will be recognized that the fire-brick lining in the bottom of the furnace and combustion chamber is a great advantage, as the hot brick will tend to keep a uniform high temperature at these places and facilitate circulation at the bottom of the boiler; whereas in the coal fire the part of the furnace under the bars is always cool, due to incoming fresh air, and the bottom of the combustion chamber is usually filled with ashes, which likewise keep these plates cool, and these differences of temperature in the same parts of boilers always cause strains in the material, shortening the life of the parts.

From Bombay to Borneo and back to London the *Cowrie* burned the crude oil just as it comes from the wells. After some experimenting the engineers succeeded in getting good results. The boiler tubes remained clean and showed no deposits of tar or heavy substances. One difficulty in handling the crude oil direct from the wells lay in the fact that such oil contained considerable water, which at times caused the burners to sputter, and occasionally extinguished the flames. The hot bricks would often relight the flame, and when this did not occur great care had to be exercised in applying the torch, owing to the accumulation of inflammable gas. This difficulty was overcome, however, by periodically draining off the water from the bottom of the gravity tank. In the future this oil will be allowed to remain for a time in a settling tank at the wells, where the water can be drawn off before loading on board ship.

From London to New York the fuel was gas-house refuse mixed with the crude oil. This gave a little more trouble, as it required occasional sweeping of the tubes. The deposit, however, was not of a heavy nature, was easily removed, and did not materially diminish the efficiency of the boilers. When leaving England for Bombay, with coal fires, nineteen firemen and trimmers

were required, and after the installation of the oil burners ten of these were dispensed with, and the vessel proceeded with only nine men. As the main boilers have three furnaces each, making a total of nine furnaces, this amounted to three firemen a watch, or one man to three fires. When everything was working smoothly one man a watch could easily have attended to the nine burners, but as the firemen were all Chinese, and the installation was something out of the ordinary, it was considered advisable to retain at least nine men. On the trip to New York, when burning the mixture, it gave trouble occasionally by stoppages in the oil pipes at the valves. This is now obviated by putting steam connections to these pipes to blow them through when stoppages occur, as the clogging material is of an oleaginous nature.

It is evident that the careful and frequent adjustment of the burner valves is of prime importance. Any neglect of this kind caused as dense a smoke from the funnel as would be produced by soft coal, while under proper adjustment the escaping gas was colorless. The temperature of the stokehold was above normal, owing to the fact that the baffling of the flames heated the furnace fronts.

One objectionable feature about the installation lies in the fact that the owners selected a burner which requires steam for atomizing the oil, as this entails a great loss of fresh water. The ship originally had one evaporator, and two additional evaporators were added to help make up the loss, but even so the boilers were salted. The small donkey boiler, with two furnaces, is used to generate the steam for the burners, and in starting up, a wood fire is built in the boiler until there is 5 or 10 lb. of steam. Then the ashes are raked out and the burners started.

No data as to the relative performance of this quality of oil compared with coal has been secured as yet. Of course, the use of oil for fuel is nothing new, as it is used extensively in land practice and also for small boats, but so far steamship owners have been slow in adopting it for use in large seagoing ships. There is no doubt that the advantages, such as reducing the size of the crew, cleanliness in handling, and the small amount of time required to load, speak very much in its favor. The question of cost is the vital one. In regard to loading the fuel, it may be mentioned that the *Cowrie* took on 313 tons in 1 1-2 hours.

An objectionable feature of the burner is that it creates such a roaring noise. When the nine burners in this ship are all going conversation can only be carried on in the stokehold by the sign language. In a vessel of this class, where the machinery is located away aft, this feature is not of great importance, but in a passenger ship it might become very annoying. As all oil burners roar more or less, however, this criticism is not derogatory to the special type of burner used on this vessel.

A New Armor-Plate Establishment.—For some time past Sir W. G. Armstrong, Whitworth & Co., Ltd., have been making extensive additions to their Openshaw Works, with the object of producing armor plates of the highest quality. These additions to buildings and equipment are now well on to completion.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—(1) At what temperature Fah. does coal oil (kerosene) freeze?

(2) What is the rule for finding the friction of air under pressure in pipes? Master Mariner.

A.—(1) In the first place it must be understood that kerosene oil is not a definite chemical substance, and that its properties depend largely on the particular proportions in which certain of the constituents are found. The chief constituents of kerosene oil form a series of chemical substances known as *pentane*, *hexane*, *heptane*, *octane*, *nonane*, etc., and containing in each molecule, respectively, 5, 6, 7, 8, 9, etc., atoms of carbon, while the number of hydrogen atoms is two more than twice the number of carbon atoms. Thus pentane would have the chemical formula C_5H_{12}, heptane C_7H_{16}, etc.

Now these various substances solidify at different temperatures in the neighborhood of 20 degrees below zero. It follows that when kerosene oil is cooled the first of these substances to solidify will make the oil cloudy and thick, and the process will gradually continue till it is entirely solid.

For commercial purposes the question of importance is not so much as to the temperature at which the oil becomes solid as the temperature at which it begins to become thickened by the solidification of one of its constituents, and its fluidity thus impaired. This may be termed the chill point, and with good commercial kerosene should not occur till the temperature is carried considerably below zero, though the presence of certain substances which solidify at higher temperatures might render it somewhat cloudy at temperatures close about zero.

(2) Various formulæ have been proposed for expressing the loss of pressure due to the flow of air in pipes. The simplest form may be expressed as follows:

$$p = .0000025 \frac{L v^2}{d}$$

in which:

p = loss of pressure in lbs. per sq in.
L = length of pipe in feet.
v = velocity of flow in feet per sec.
d = diam of pipe in inches.

The use of this formula may be illustrated by the following example.

Suppose 60 cu. ft. of air per minute is discharged through a 2 in. pipe 400 ft. in length, the initial pressure being 80 lbs. Find the loss of pressure at the discharge end.

The area of the pipe is 3.1416 inches, and the volume discharged is 60 cu. ft. or 103,680 cu. in. per minute. Hence the velocity of flow is 103,680 ÷ 3.1416 in. per mt. = 33,000. This reduced to ft. per sec gives 33,000 ÷ (12 × 60) = 43.

Hence substituting in the equation above we have

$p = .0000025 \times 400 \times 43 \times 43 \div 2$ or $p = .9$ lb. or the pressure at the discharge end would be reduced about 1 lb. or to about 79 lb. per sq. in.

The North German Lloyd liner *Main*, which was burned in the dock fire at Hoboken, N. J., June 30, has been towed to the Newport News shipyard for complete repairs.

On the occasion of the visit of the Greek warship, *Navarchos Miaoulis*, to the port of New York last month, a silver loving cup with an appropriate inscription was presented to the vessel by Greeks resident in various parts of the United States.

Another steamship pier fire occurred at the port of New York, October 6, at the Atlantic Transport dock. The fire seriously damaged the structure, besides consuming a quantity of freight before the fire boat and land engines drowned it out. There was no ship in the berth at the time.

MARINE ENGINEERING.

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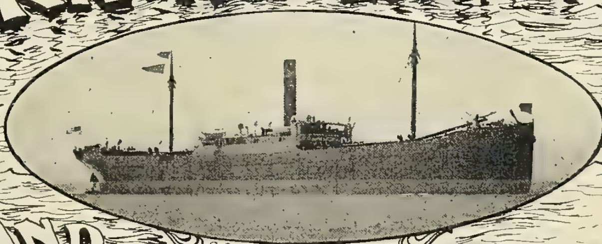
EIGHTH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

T. S. S. CHESTER W. CHAPIN

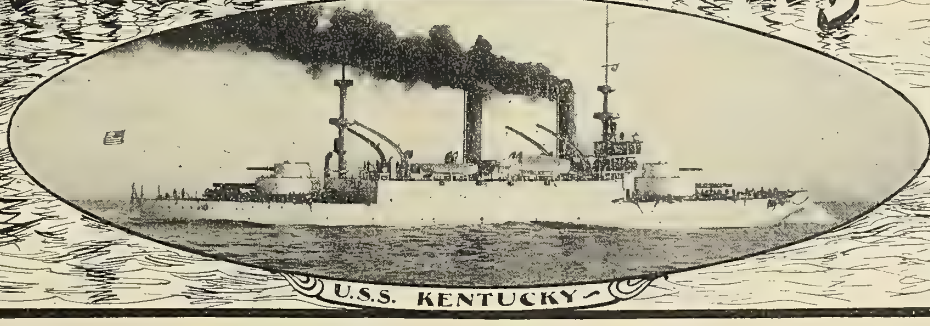
T. B. D. LAWRENCE

S. S. GRECIAN



S.S. CALIFORNIAN

THERE was enough expertness in the auditorium at Engineering headquarters, 12 West Thirty-first street, New York, on the occasion of the opening of the eighth annual meeting of the Society of Naval Architects and Marine Engineers, to have constructed an entire navy of war vessels, and a merchant fleet of every size and type, in addition, at the briefest notice. Looking about the room one could readily recognize members identified with the creation of ships of the line,



U.S.S. KENTUCKY

cruisers, torpedo boats, coast liners, deep sea vessels, and pleasure yachts; in fact, boats of every size and style, for there are fashions in boats as in garments, and besides the naval architect, the marine engineer, pure and simple, claimed his share of the floor. There were many all the way up or down, as you will, from the side wheel engine expert to the man who juggles with two hundred-odd pounds and piston speeds beyond the thousand mark. These members had come from the Coasts, the Lakes, and beyond the seas to take part in this the event of the year in marine construction circles. Some, whom the present boom in construction kept at home, were heard in written argument, so that while not in the count of heads their views were heard in debate. There were the ingredients proper to a successful gathering, the weather was propitious, the members enthusiastic, and the presidential address told not only of the profitable present, but forecast an increasing share of the world's tonnage for American skill.

It was singularly unfortunate, therefore, that the peace and dignity of the meeting should have been interrupted at the closing session by the introduction of personalities in purely technical discussion.

An unexpected feature of the meeting was the announcement by Secretary-Treasurer Francis Bowles that a member of the Council had offered a prize of one hundred dollars for the best paper, presented at the next meeting, on a subject to be selected. The choice fell upon the topic of "Theoretical and Practical Methods for Balancing Marine Engines."

Another unexpected feature was the contribution of a paper on the recent trial performances of the Russian Cruiser *Variag*, read at the meeting by Charles Cramp, a member of the firm of builders of this speedy vessel. Mr. Cramp, on behalf of his firm, extended a cordial invitation to the members to visit the ship yard on the Delaware, and on the day after the meeting, November 17, a special train conveyed the guests to the Cramps' Ship Yard, where they inspected the *Variag* and were hospitably entertained at luncheon.

An invitation to attend the Glasgow Engineering Congress, to be held in September, 1901, in connection with the Glasgow Exposition, was announced by the President as having been received. Upon the suggestion of the Secretary members who contemplated making the trip to the Glasgow conference next year were requested to send in their names so that the Executive Committee could appoint a committee to represent the Society at the Congress.

President Clement A. Griscom, who was abroad when the 1899 meeting was held, was in the chair when the eighth general meeting was called to order. First in the order of business was action on the annual financial statement.

ANNUAL REPORT OF SECRETARY-TREASURER.

Secretary-Treasurer Francis T. Bowles reported a total membership of 669, an increase of about 100 over the number in the previous report, and this amount was increased by nearly 100 new applications for membership, to be voted in at the meeting. During the year five members had died:

Members—Stephen A. Gardner, J. G. A. Meyer, Isaac G. Sowter. *Associates*—S. Dana Greene, Fairman Rogers; and there were twelve resignations, including:

Members—Cipriano Andrade, Henry E. Rhoades, Nisbet Sinclair. *Associates*—Luther Allen, Lester A. Beardslee, Emmanuel Cheneau, Marshall H. Clyde, Millard Hunsiker, G. W. Littlehales, C. L. Ottley, Richard Rush. *Junior*—Edwin B. Katte.

Receipts during the year amounted to $6,115.56, which, with the balance on hand of $3,586.75, made a total of $9,702.31. Expenditures, including investments, reached $8,009.57, leaving a cash balance of $1,692.74 to be carried over. Liabilities of the Society were represented by a cipher, and the resources footed up over $15,000. The report was unanimously adopted.

ADMISSIONS TO MEMBERSHIP.

On the list of applications for admission to membership, recommended by the Council, were included several European engineers who are identified with merchant and naval work. To the home applications juniors contributed a considerable share, showing that the younger element have a live interest in the promotion of the best interests of American marine construction. In this section of the Society there are without doubt many that, as experience ripens, will figure in meetings in the future as authors of valuable papers and leaders in debate. The complete list of new members reads:

Members—Bartlett, Charles H., Draughtsman, Navy Yard, 9 Concord Square, Boston, Mass. Bauer Max Henrich, Asst. Teacher, Royal Technical High School, Berlin, Germany. Bigelow, Frank Lewis, Pres. The Bigelow Co., New Haven, Conn. Brewer, Charles B., Draughtsman-in-Charge Naval Constructor's Office, Maryland Steel Co., Sparrow's Point, Md. Buckelew, Charles Henry, Manager New York Office, Ashton Valve Co., 126 West Fifth street, Plainfield, N. J. Cook, Fred M., Leading Hull Draughtsman, Bath Iron Works, Union Street Court, Bath, Me. Cop, Huibert, Prof. Naval Architecture, Polytechnical School at Delph, Cost Singel 61, Delft, Holland. Davis, Charles H., Consulting Engineer, 99 Cedar street, New York, N. Y. Ebsen, H. L., 230 West street, New York. Elwell, H. P., Fore River Engine Co., Weymouth, Mass. Hall, Thomas S., Supt. Engineer New York and Texas S. S. Co., No. 16 Burling slip, New York, N. Y. Herbert, Frederick D., Consulting Engineer and Naval Architect, 220 Broadway, New York, N. Y. Hopkins, Edward, Chief Draughtsman, Detroit Shipbuilding Co., Detroit, Mich. Hunter, George Burton, Chairman and Director C. S. Swan & Hunter Co., Ltd., Wallsend-on-Tyne, England. Lignola, Raimondo, Naval Constructor Royal Italian Navy, R. Cantiere di Castellamare di Stabia, Italy. Norton, Harold P., Lieutenant, U. S. Navy, Navy Department, Washington, D. C. William F. Palmer, Managing Owner and Designer, No. 27 Hartford street, Dorchester, Mass. Pauli, Sven, Asst. Naval Constructor, Carlskrona Navy Yard, Carlskrona, Sweden. Pfatischer, M., Electro Dynamic Co., Philadelphia. Pommer, Eugene R., Ship Draughtsman, Navy Yard, Boston, 102 Hancock street, Malden, Mass. Row, Reuben Robert, Senior Draughtsman Marine Dept., U. S. Light House Service, 227

S. Broadway, Baltimore, Md. Savage, Silas Anthony, Asst. Supt. Engineer, U. S. Light House Board, Washington, D. C. Scott, John Thomas, Supt. Iron Works' Shops, San Francisco, Cal. Smith, W. B., Crescent Ship Yard, Perth Amboy, N. J. Thomas, C. C., University of New York. Thumm, William F., Charge Designing Dept., Wm. Cramp & Sons E. & S. B. Co., Philadelphia, Pa. Wellington, Frank O., Fore River Engine Co., Weymouth, Mass. Wetherbee, Charles Phelps, Asst. Supt. in Charge Torpedo Boats, Bath Iron Works, Bath, Me. Wheeler, Clifton H., Pres. Wheeler Condenser and Engineering Co., 120 Liberty street, New York, N. Y. Winship, James G., Mechanical Engineer and Salesman, Geo. F. Blake Manfg. Co., 468 Greene avenue, Brooklyn, N. Y. Woody, William Henry, Jr., Asst. Supt. Charge of Hulls, Wm. R. Trigg Co., Richmond, Va.

Advanced from Associate to Member—Ferguson, H. L., Assistant Naval Constructor, Washington. Michael, Lucius M., Draughtsman Harlan & Hollingsworth Co., 1514 Van Buren street, Wilmington, Del. Miller, Spencer, Lidgerwood Mnfg. Co., New York. Wallace, W. M., Computer Bureau Construction and Repair, Navy Department, 616 Eighteenth street, N. W., Washington, D. C. Wilson, G. H., Harlan & Hollingsworth Co., Wilmington, Del. Zahm, Frank Baker, Naval Constructor, U. S. N., Navy Department, Washington, D. C.

Associates—Bent, F., Solid Steel Casting Co., Chester, Pa. Bent, Stedman, Maryland Steel Co., Sparrow's Point, Md. Boas, Emil L., 37 Broadway, New York. Buckelew, Charles William, Ship Designer, 126 W. Fifth street, Plainfield, N. J. Capdevielle, Henry, Ship Draughtsman, Newport News S. B. & D. D. Co., 113 Thirty-third street, Newport News, Va. Clifford, James A., B. F. Sturtevant Co., Boston. Coolidge, Frederic Austin, Copyist Draughtsman U. S. N., Harlan & Hollingsworth Co., Wilmington, Del. Cooper, Percy Gordon, Ship Draughtsman, Newport News S. B. & D. D. Co., 124 Thirty-fifth street, Newport News, Va. Etter, Harry B., Designing Draughtsman, Wm. Cramp & Sons, E. & S. B. Co., 2339 N. Twentieth street, Philadelphia, Pa. Farrington, W. C., Northern Steamship Co., Buffalo. Fergen, Captain William Baron, Naval Attache, Imperial Russian Embassy, 2010 R street, N. W., Washington, D. C. Gibson, Albert N., Draughtsman, U. S. N., Navy Yard, Boston, Mass. Greene, Winthrop Darius, Draughtsman, Bath Iron Works, P. O. Box 855, Bath, Me. Green, C. Cuyler, Draughtsman, Hyde Windlass Co., P. O. Box 1015, Bath, Me. Hill, Geo. H., Sprague Electric Co., New York. Hoffman, John White, Pres. Hoffman Eng. and Contracting Co., Harrison building, Philadelphia, Pa. Hooper, Louis Mosher, Engineer and Mechanical Expert, J. L. Mott Iron Works, Rutherford, N. J. Hughes, Alex., 623 Jefferson street, Portsmouth, Va. Lawley, Arthur C., Draughtsman, Geo. Lawley & Son Corp., 60 N. street, South Boston, Mass. Lynn, James J., Marine Salesman, General Electric Co. and Shelby Tube Co., 4 Butler street, Port Huron, Mich. McBride, James D., New York Ship Building Co., Camden, N. J. Main, Archibald MacNicol, Eastern Ship Building Co., New London, Conn. New, Harry Stuart, Draughtsman, Navy Yard, 221 Newbury street, Boston, Mass. Newberry, Truman H., Detroit. Nolan, John J., Master Mechanic C. and R. Dept., Navy Yard, New York, 271 Adelphi street, Brooklyn, N. Y. Norman, John Hugo, Draughtsman, Wm. Cramp & Sons, E. & S. B. Co., Philadelphia, Pa. Paine, Cecil E., Engineer Hyde Windlass Co., Bath, Me. Patteson, Hugh, Sprague Electric Co., New York. Pierce, Walter Louis, Secretary and General Manager Lidgerwood Mnfg. Co., 96 Liberty street, New York City. Pollock, W. B., Marine Dept., N. Y. C. & H. R. R., New York. Powers, Wilbur Francis, Draughtsman, Harlan & Hollingsworth Co., 1219 Washington street, Wilmington, Del. Raven, Anton A., Pres. American Bureau Shipping, 37 William street, New York, N. Y. Roach, S. W., Morgan Iron Works, New York. Robinson, Richard H. M., Asst. Naval Constructor, U. S. N., Cramps Shipyard, Philadelphia, Pa. Roes, W. Harry, Hull Draughtsman, Wm. Cramp & Sons. E. & S. B. Co., 5420 Jefferson street, Philadelphia, Pa. Ross, Charles E., Morgan Iron Works, New York. Sabin, Alvah Horton, Chemist and Director, Edward Smith & Co., 45 Broadway, New York, N. Y. Schooler, C. V., 511 County street, Portsmouth, Va. Shackford, William Gardner, Retired Shipmaster, South Orange, N. J. Stanton, L. W., *Nautical Gazette*, New York. Thayer, Charles Hinckley, Ship Draughtsman, Newport News S. B. & D. D. Co., 136 Thirty-eighth street, Newport News, Va. Thresher, A. A., Thresher Electric Co., Dayton, O. Tromp, Theodoor Henri Adrian, 1302 Washington street, Hoboken, N. J. Wakeman, S. W., Newport News Shipyard, Newport News, Va. Waters, Geo. H., Asst. Master Mechanic Pennsylvania Co., Jersey City, N. J. West, G. B., Eastern Shipbuilding Co., New London, Conn.

Advanced from Junior to Associate—Swanton, H. A., Harlan & Hollingsworth Co., Wilmington, Del. Tuthitt, Benjamin Cartwright, Asst. Draughtsman, U. S. N., Bath Iron Works, 146 Oak street, Bath Me.

Advanced from Junior to Member—Delong, H. W., Marine Dept., Maryland Steel Co., Sparrow's Point, Md. Sperry, Austin, Fulton Engineering and Shipbuilding Co., San Francisco.

Juniors—Baum, A. E., 32 Western avenue, Bath, Me. Bimson, James A., Draughtsman, Engineering Dept., Bath Iron Works, Bath, Me. Crain, John Jay, Draughtsman, N. S. N., Newport News S. B. & D. D. Co., 329 Forty-ninth street, Newport News, Va. Cutler, Edward Osgood, Draughtsman, U. S. N., Bath Iron Works, 97 Oak street, Bath, Me. Damon, Edward O., Jr., 83 Pomroy terrace, Northampton, Mass. Dawson, Noble Edmunds, Jr., Hull Draughtsman, Newport News S. B. & D. D. Co., 3406 West avenue, Newport News, Va. Ellis, Walter L., Draughtsman, Bath Iron Works, Bath, Me. Evans, John Lancaster, Ship Draughtsman, Bath Iron Works, P. O. Box 838, Bath, Me. Frieble, John F., Draughtsman Hull Dept., Newport News S. B. & D. D. Co., P. O. Box 92, Newport News, Va. Grieshaber, Hugo Eugene, Merchant Draughtsman, Newport News S. B. & D. D. Co., P. O. Box 92, Newport News, Va. Hibbard, Harry Lyman, Asst. Ship Draughtsman, Naval Construction Office, Newport News, Va., Chas. Haynes Hughes, Ship Draughtsman, Bath Iron Works 658 Washington street, Bath, Me. Hunt, Herman Reynolds, Ship Draughtsman, U. S. N., 719 St. Nicho-

las avenue, New York, N. Y. Jenkins, Sanford Cuyler, Draughtsman, Wm. R. Trigg Co., Box 861, Richmond, Va. Leitch, A. C., Navy Yard, New York. Loomis, Allen, Draughtsman, Hanley Construction Co., Quincy, Mass. Lord, Robt. William, Hull Draughtsman, Bath Iron Works, 25 Linden street, Bath, Me. Mitchell, Leland R., Marine Engine Draughtsman, Bath Iron Works, 476 Middle street, Bath, Me. Newton, William Buxton, Engine Draughtsman, Bath Iron Works, 850 Washington street, Bath Me. Schoonmaker, Frederick, Draughtsman, Hull Dept., Bath Iron Works, 146 Oak street, Bath, Me. Page, Charles Barnard, Engine Draughtsman, Maryland Steel Co., Sparrow's Point, Md. Wright, Henry C., Jr., Hull Draughtsman, Wm. R. Trigg Co., Richmond, Va. Yeomans, Clifton, Draughtsman Hull Dept., Newport News S. B. & D. D. Co., P. O. Box 60, Newport News, Va. Young, William J. J., Asst. Draughtsman, U. S. N., Geo. Lawley & Son, 15 Cottage Side, Dorchester, Mass.

ELECTION OF OFFICERS.

The only change in the existing list of officers is the addition to members of the Council of Walter A. Post. For the ensuing year, therefore, the officers of the Society will include: President, Clement A. Griscom; Vice-Presidents, W. Irving Babcock, Francis T. Bowles, Washington L. Capps, French E. Chadwick, James E. Denton, George W. Dickey, William F. Durand, Edward Farmer, H. T. Gause, Nathaniel G. Herreshoff, William H. Jaques, John C. Kafer, Frank B. King, Frank E. Kirby, Walter M. McFarland, Jacob W. Miller, Lewis Nixon, Cecil H. Peabody, Walter A. Post, Harrington Putnam, Horace See, E. Platt Stratton, Stevenson Taylor, George E. Weed; Executive Committee, Francis T. Bowles, Chairman; H. T. Gause, Harrington Putnam, Lewis Nixon, Edwin A. Stevens, Clement A. Griscom, ex-officio; Secretary and Treasurer, Francis T. Bowles.

Routine business matters having now been disposed of, President Clement A. Griscom read his annual address.

PRESIDENT GRISCOM'S ADDRESS.

"*Gentlemen:* I am grateful for the continued evidence of your confidence, which I highly appreciate.

"The long list of new members we shall add to our rolls at this meeting is but one of the abundant signs to be read in the industrial, financial and political life o fthese November days, of a national determination to promote shipbuilding, commercial and naval. In pursuit of its special object this Society, I confidently predict, has an immediate future of great usefulness to our country.

"The most prosperous year shipbuilding in the United States has known since the outbreak of the Civil War nears its end.

"The new year and the century about to begin bid fair to witness a development of the industry responsive to our high hopes at the time the Society of Naval Architects and Marine Engineers was founded.

"During the fiscal year of the Government which ended in June, eighty steel steam vessels of 167,948 gross tons were built in the United States. These figures are modest compared with Great Britain's output of 567 steel steam vessels of 1,341,425 gross tons during the year; but they are full of encouragement when put beside the fact that during the previous nine years the United States built only 574,802 gross tons of these types. Nearly all our ship yards have been busy, every large plant has increased its capacity, and several new ship yards have been established and equipped for the construction of the largest merchant and war vessels. The new ship and engine building yard of noble proportions on the Delaware is prepared for work, and its novel applications of mechanical science to shipbuilding have already aroused the interest of the students of marine architecture here and abroad. A new and extensive plant on the Pacific Coast will soon begin operations and on the Thames, in Connecticut, the keels of two of the largest steamships ever built will soon be laid. Plants in the South are increasing their facilities, and, under favorable conditions, steel shipbuilding promises to become one of our distinctively national industries.

"The next twenty-four months will show an increase over the past twenty-four months as great as the records of the latter exceel those of previous periods. Since the end of June there have been launched, begun or contracted for, seventy-eight steel steamships of 350,000 gross tons, including ten ocean steamships, each of 10,000 gross tons or over. Part of this work will extend over a period of two years, but in the twelvemonth from last June, 250,000 tons of steel steamships will have been launched in the United States.

"Unless I mistake its scope, this society has two functions. First, by the interchange of professional ideas to extend to our own knowledge and familiarize ourselves with advances in the technical aspects of the art; and, second, to promote shipbuilding by teaching the value to the nation of the work in which we are all directly or indirectly engaged, and by developing a correct popular understanding of the broad facts of the industries with which we are identified.

"You will not expect a technical paper from me. Such papers have been prepared for the meeting by gentlemen whose abilities in their respective lines of work command the highest professional esteem. But, as your president, I deem it well at this time to point some of the causes which, in my judgment, have brought the recent remarkable growth in American shipbuilding to which the figures just stated testify.

"Most familiar among those causes has been the liberal and continuous expenditure of the Government on the navy. Since 1884-5, seventy-one vessels of over 360,000 tons displacement, not including many torpedo boats and torpedo boat destroyers, have been built or ordered for the navy. The vessels under construction aggregate 113,326 tons displacement, namely: Six battleships, four monitors, six protected cruisers, sixteen torpedo boat destroyers and fifteen torpedo boats, making a total of forty-seven.

"The total value now under construction for the United States navy for hulls and machinery alone involves an expenditure of $33,700,000.

"Vessels have been authorized but not yet begun, namely: Five battleships, six armored cruisers and three protected cruisers, making a total of fourteen, and aggregating 179,800 tons displacement, of which

the hulls and machinery alone will cost approximately $50,400,000, a greater amount than is involved in the entire construction of the merchant steamships of twenty-four months to which I have referred.

"The annexation of Hawaii and causes arising from our war with Spain have stimulated shipbuilding beyond the expectations of the sanguine a few years ago. Among such causes are the extension of the coasting law to Porto Rico, the development of closer relations with Cuba, the absorption of a large tonnage by the Government for transport purposes and especially the certainty that the United States is now impelled by the force of events to assume first rank as a maritime commercial power on the Pacific.

"Under natural and legislative conditions which insure them against external competition and have obtained for them deep channels, our shipbuilders on the Great Lakes have brought the art to a wonderful perfection. Of the increase of 750,000 tons in American shipping during the decade, 500,000 tons—450,000 of which are steel steam vessels—stand to the credit of the shipbuilders and shipowners of the Great Lakes.

"Without transgressing any unwritten rule of the Society in its discussions, I feel justified in stating that among the causes which are now stimulating our shipping interests may be included the growing popular national sentiment that the United States should no longer remain at the tail of the procession of commercial nations on the seas. Within four years our country has won a series of remarkable industrial triumphs, yet Japan, the youngest of nations, surpasses us in the tonnage of ocean steamships engaged in the world's commerce. I shall not presume to discuss here the public measures that may be desirable to meet the situation. Papers will be laid before you on certain phases of the problem, to which your thoughtful attention is invited. I have shown that conditions exist which promise success for a well-considered project, sustained by enlightened public sentiment.

"I congratulate the members upon a programme of unusual interest."

First Technical Session.

The proceedings were opened by the announcement by President Clement A. Griscom of the reading of the first paper on the programme.

CAPACITY TEST OF A UNIQUE FORM OF AIR PUMP.

BY T. W. WHEELER.

The Author, who is a manufacturer of pumps, describes in detail a type of air pump which has been put on the market recently by his firm. It is of the independent variety, and in the steam end is similar to the simplex double acting steam pump arranged on the cross compound plan, built by the Author, and described by him in a paper read before the Society at the 1899 meeting. The air cylinders of this pump are described as of the "suction valveless" principle, each air cylinder being double acting. The discharge valves for the end of the pump are arranged at the top of the air cylinder immediately over the pump barrel, and the discharge valves for the other end are located at one side of the cylinder casting as low as they can be placed. The air piston is a hollow casting of gun metal bronze filled with material of great lightness and water excluding qualities. This piston is sufficiently elongated, and alternately covers and uncovers the suction port at each stroke, this suction or inlet port being located at the center of the cylinder. There are no suction valves and the air piston has no packing rings. Accompanying the paper there are diagrams of the pump, indicator cards and a numerical table of test performances.

DISCUSSION.

Mr. Kafer: "I would ask if the indicator diagram of the air pump was from the upper or the lower part of the cylinder, because it would make an essential difference whether the diagram was taken from the upper or lower end. A pump similar to this was designed by Mr. Bailey some years ago. He thought he had a new invention, but he found a similar pump had been designed many years before and a description published in an English engineering paper. There is no question that this style of pump is superior as an air pump, from the fact that the air pump, from the fact that there is no foot-valve or receiving-valve to raise, and, consequently, no pressure of air in the condenser necessary to raise that valve, and it is possible to produce a better vacuum with a valveless pump on the receiving side than it is with one having a valve on it."

W. I. Babcock said that one of the most important parts of a marine engine is that portion which is concerned with the production of a vacuum, in which the air pump is the main factor. If this can be associated with simplicity of design, with constancy of operation and with a large saving of weight, it amounts to a very great advantage in engine practice. He asked for specific information as to the construction of the discharge valves referred to in the paper.

Mr. Wheeler, in reply to Mr. Kafer's inquiry, said that when the design for a suction valveless pump had been prepared by Mr. Bailey, some years ago, the designer had then thought that he was the originator of the principle; but, as a matter of fact, the Knowles Steam Pump Works made a pump of the suction valveless type for vacuum pans in 1874. It was an efficient pump, but in the course of a year or so it lost its vacuum forming qualities because it was a horizontal pump and, having no vacuum rings, the piston would wear on the lower side and then the pump would leak from the top side. Pumps of this type had also been designed in England. In fact, the Edwards Air Pump, now extensively sold abroad, is on this principle. In reply to the query about the indicator diagram, the speaker forgot whether it was from the lower or upper side. But out of forty or fifty diagrams there was a great difference between the top and the bottom. Air pumps were very eccentric in their action, the speaker said, and there are practically no two diagrams alike. This was especially so when a vessel was in motion, rolling—sometimes there would be a gorge of water and then a scarcity of it—and the diagrams were consequently very irregular. In this pump it was expected that more work

would be done on the lower side than on the upper side of the piston, but the diagrams did not always show this; although the average showed a little more work on the lower side. Naturally, it would be said that the vapors and air would rise and pass off on top, and that the water would gravitate to the bottom, and that, consequently, the lower stroke would be a water stroke and the upper stroke would be a vapor stroke. The vapors, however, mixed more or less with the water in practice, and it was not surprising that a uniformity of diagram was obtained.

John C. Kafer said that not only would the water go to the bottom, but also there would be less vacuum in the lower portion of the pump, due to the clearance space. All this space in the lower portion of the pump would be filled with air or vapor, while in the upper portion all the air and vapor would be discharged.

Mr. Wheeler replied that in practice the water filled the lower space so that it was almost solid. With respect to the valve, this was of the type known as the three-disc Kinghorn valve, and was made of manganese or phosphor bronze, carefully fitted, and as tight as a rubber valve. With these valves trouble was sometimes caused, when first starting a pump, by the moulder's sand and dirt in the connecting pipes. To guard against this, the pipes were usually cleaned out before commencing operations. This would, of course, have occasioned less trouble with a rubber valve.

W. D. Forbes inquired whether, when the piston was passing the feed inlet, there was any shock noticeable. Was it a perfectly horizontal slot, or was it partly spiral?

Mr. Wheeler responded that it was perfectly horizontal. It went around about three-fourths of the barrel and the piston passed it without any perceptible noise or jar.

W. D. Forbes: "Then the pump was practically noiseless."

Mr. Wheeler responded that it was noiseless if proper care was exercised, but that like all air pumps it would pound under certain conditions. He believed that Mr. Bailey had reached similar results in his experiments.

INTERCHANGEABILITY OF UNITS FOR MARINE WORK.

BY W. D. FORBES.

In this brief paper the Author aims to call attention to the desirability in machine construction not only of interchangeability of parts but of units, so that discussion of the subject may be provoked. In opening he states that the great advantage of interchangeable machine parts is nowhere more fully recognized than in the United States, this feature of our construction being one of the strongest recommendations of American machinery to the foreign buyer. The cost of repairs or replacement of apparatus on board ship as compared with costs for like work in the shop is noted by the Author. This is caused in part by the necessity for men going to and fro to the work, and carrying out the work usually in cramped and crowded quarters. He suggests that the Navy is in a position to start a system of interchangeability of units in its auxiliary machinery without in any way making it necessary to use a certain make or style of machine, or without inflicting on the manufacturing public any real burden. It is proposed, for instance, that all generating sets, of whatever make, of the same K. W. output, shall have the base plate holding down bolts in exactly the same position, and the steam inlets and outlets in the same relative positions in vertical and horizontal planes. It does not seem practcal to carry out this idea entirely, the Author believes, but it could be approximated to so that less work would be needed in substituting one size of apparatus for another, even of different makes. Changes in piping are readily made on shipboard, he points out, and if the holding down bolts do not call for changes, the process of replacing apparatus becomes simple. In the commercial world, now, designs are fairly well fixed, but as new designs are being constantly brought out, these could be made to conform to the interchangeable system. The main difficulty is that at present no standard exists, but, the Author believes, were a system adopted, manufacturers would speedily fall into line. A commencement could more readily be made in the Navy, as most of the govermental work is specially gotton up. A standard flange for steam and water connections of pipe is now in use in the Navy. Taking two Admiralty pattern pumps of different sizes as examples, the Author shows by figures that comparatively slight changes would be needed to make the pipe openings and holding down bolt holes in each type coincide. Electric units lend themselves especially to the interchangeable system, as in their case only the position of the steam and exhaust pipes and the holding down bolts would have to be considered. In many existing types few changes would have to be made to secure interchangeability. The same method could be readily adopted for circulating pumps, blower, engines, etc. In some parts of the world, the Author says, small marine engines are made interchangeable, so that instead of making repairs, in place, the engine is lifted bodily out of the hull and another engine dropped in and immediately coupled up. In conclusion, the Author recalls the scepticism with which in days past the proposition to make band pulleys for stock was received. "Engineers insisted that a hole could not be made in Philadelphia, to fit a shaft made in New York." A similar prediction was made when it was proposed to manufacture stock gears. Accompanying the paper are outline dimensional sketches of the Admiralty pumps referred to in the text.

DISCUSSION.

Naval Constructor Francis T. Bowles said: "I believe that this matter which has been brought up by Mr. Forbes is the most important one that this Society can consider in the interest of shipbuilders and shipowners, and I believe that the idea can be carried out in a much larger way possibly than Mr. Forbes has considered. Interchangeability of units is applicable, not only to the fittings of the engine room and auxiliaries of the ship, where it has a noticeably large field, but it can be extended with great economy to the fittings of all vessels, and I would like to say that for the last three years I have

been engaged in preparing standard plans, some of which I have restandardized several times, for customary fittings on board ships, such simple things as eye-bolts, blocks, pulleys, ventilator rings and ventilator cowls, cleats, bits and things of that sort. Now, if the shipbuilders of the United States would get together and agree upon standardizing even such small details as that, it would be an enormous saving. Those things could be produced in large quantities for less than one-third of what they are produced for now, in irregular sizes. The shipowner would never be at a loss to obtain whatever he required immediately, and I consider that this line of improvement is one of the greatest fields in this country to put us ahead of others in the shipbuilding business."

John C. Kafer: "I fully agree with what Mr. Bowles has said with reference to interchangeability of parts of ships and machinery. Wherever you can interchange parts you can save money, save money for the shipowner more especially. He is the man for whom we want to save money in the end, and the shipbuilder can get his supplies much more readily, but it goes to the manufacturer of these parts to make them uniform. One builder of pumps will not make the pumps exactly the same as another man. He will endeavor to make a change, so as to compel people to come to him for pumps. I mention that without any disparity to the pump makers, merely because the subject of pumps was brought up. But if the manufacturers would endeavor to make them uniform, there would be very little difficulty on the part of the shipbuilders or the shipowners to aid them in the matter. Probably this Society would be the proper place to make a start in that direction. If a committee of shipbuilders and manufacturers would get together and standardize some of the parts, begin with some few things, not attack the whole; but make a small beginning, I think it would lead on to a successful result in the matter."

Naval Constructor William J. Baxter said: "One very valuable feature in this paper, which has not been mentioned by Mr. Bowles or Mr. Kafer, is the elastic limit of this method. It allows of variation for the different pump makers, as Mr. Kafer has mentioned, for the different cleats, for the different fittings that will satisfy any particular shipbuilder, or any particular manufacturer. But it makes a limit in certain fixed dimensions, and by having these certain dimensions fixed to absolute standard, there still is this opportunity for each individual firm to show what it can do on the given dimensions to make their particular fitting, whether it be a dynamo, whether it be a cleat, to make that, as every man tries to do, better than anybody else. But by having this particular system of absolute fixed dimensions of certain absolute points, if that can be done by this Society or by any other convention, I think a very long step forward will be made."

Mr. Wheeler said the pump makers experienced a good deal of difficulty in trying to please customers. In the matter of nozzles, for instance, the Navy Bureau had a fixed standard, while many of the merchant yards had their own standards. It was difficult to adopt a standard, as advancement was being made all the time in internal improvements which necessitated a change in design. In this country what was good to-day was out of date to-morrow.

Walter M. McFarland said that in another society he was associated with Mr. Forbes as a member of a committee on standardization. Their experiences were very gratifying indeed, as the manufacturers were all eager for it. With that committee it was a question of getting the builders of engines and electric generators together on certain dimensions where their parts came together. There were only a few points about apparatus of this sort that would necessarily have to be made to a standard. All that would be necessary probably would be uniformity in flanges, in their diameter and distance from centers, and uniformity in the bolt holes, so that the machine could fastened down readily. All the other details could be made by each builder as he pleased. The reason that a standard was needed for this apparatus was not because the user wanted one particular make of pump built in that way, but that he would be able to make the pump seating, for instance, in such a way that it would not only fit this particular pump, but that if he had occasion to substitute for it another make of pump, it would fit equally well. The manufacturers with whom the committee conferred said that a standard system would save them a great deal of trouble, as they would not have to make so many patterns. The speaker believed that if the matter were handled right, a good deal of good might be accomplished.

Mr. Wheeler said that as regards duplicating parts that was a system which he had adopted for many years, so that a piece could be taken out of stock and put into a pump and would fit exactly.

F. L. Du Bosque: "Bearing on what was said last by Mr. Wheeler and Mr. McFarland, I am very sorry to have to add testimony to the effect that pump people do not build to standards. We have lots of experience of that. If we break a piston of an ordinary 6-4-6 pump, it is necessary to build the piston almost from the foundation before we get a new one. That same principle carries through almost all the parts of pumps. Some time since we decided on a standard fire pump service on a different equipment. The pump given us at that time was very satisfactory. We kept ordering it from year to year, and probably eighteen months elapsed between subsequent orders, when we were told: 'We cannot build any more of this kind of fire pumps, we have to take the suction out on a different side.' The result was that half a dozen pumps we have in service are not interchangeable with pumps that we have to buy to-day. When we asked for the reason of taking the suction out of a different side, and not out of the end, they gave no other reason than that they had changed their patterns. These things are very annoying to consumers. I think that the interchangeability of parts has one advantage which is lost sight of in this discussion. I think it is one of the best insurances you can possibly have. Everybody knows if you are prepared to meet an emergency, that that emergency never happens. Our company has followed the plan of interchangeability to a very large extent. With a large equipment it is

necessary to do that. Break downs are occurring all the time, and you must keep in stock things to replace these break downs. I remember an instance illustrating the protection afforded by having spare parts. About six or seven years ago we had a very serious accident on one of the ferryboats, where a cylinder of an engine was entirely demolished, and to lay up a ferryboat is quite a costly item. One of the tugboats was sacrificed, brought to the shop, a cylinder taken out and put in the ferryboat, and inside of twenty hours the ferryboat proceeded on its way. It is only by strict interchangeability that such work can be done, and such economies effected. Appreciating that we might have the same trouble again, we ordered two cylinders, had them finished up, put one in a tug and the other in the shop. That was seven years ago, and the cylinder still remains in the shop. We keep on hand spare shafts, I might say six or seven pieces of shaft in our shop necessary for probably fifty or sixty boats. We sacrifice a little bit to weight in making a shaft a little too large for one fit in order to use the same size as used on another fit, and we find it pays very well to do it. So far as constructing machinery and engines standards, when made by different builders, I think that that has been worked satisfactorily in this way: We have probably ten separate engines of one class built in the last four years, and they have been built by four different shipbuilders, and I think that almost any part of any one engine will fit all the other engines, for the reason that at the beginning we insisted that all parts be made from the same patterns. That is, the patterns of the engines became our property; templets were made of the different fits at once, and the first engine was built from those patterns and templets. They have been subsequently sent to different ship yards, where engines have been built, so that the problem of building engines at different places is met in that way. There is no reason at all why interchangeability cannot be carried out, even in rather large designs. It is practically carried out by our people."

Naval Constructor Francis T. Bowles suggested that Mr. Forbes bring his paper to some practical purpose by making a suggestion as to how the work could be done, who would do it, and who would pay for it? It would take time and money to accomplish anything. He inquired if the government was going into this matter of standardization, and if so, in what manner it was to be done.

W. D. Forbes, in reply, said that he had entirely misunderstood the temper of the members. He had thought in preparing the paper that he was probably putting forward something that would not be wanted, but he was very much flattered to find that all the members seemed to be deeply interested in the question In answer to Mr. Bowles, he said he believed that the United States Navy should start this matter. It would cost money, but at the same time, it would save an immense amount of money. In many cases it would enable a ship to sail on time and sail in proper condition, where otherwise a large amount of work might have to be done at the dock. He suggested that the Navy start, for instance, in the matter of pumps, and referring to the committee upon which Mr. McFarland and the speaker were serving, he believed that when the standardization of electric generating systems was accomplished the Government would gladly take it up. He suggested further that a start might be made by the Navy in regard to the small launch engines, o that one could be substituted for another. Everyone recognized the value of interchangeability of parts, but in this case it was the *unit* that was under consideration. He wished this to be like a chair, which you could sit down on, no matter of what style or make, if you had the proper platform to put it on. He believed the Government should take the matter up and insist on certain standards, as had already been done in the case of flanges. He did not agree with Mr. Wheeler as to the difficulties that would be met, as anything could be changed when there was a reason for changing it; and in this case the reason would be that the manufacturers would want to sell their apparatus to the Government.

Mr. Bowles: "I had hoped to get a more explicit answer from Mr. Forbes. You know we read in the newspapers that the Government has trouble in agreeing with itself on a good many things. Now, if the Navy is to do this thing, there ought to be some means provided by which a responsible body can do it, and do it properly and do it effectively. It seems to me that, if the Society has taken this matter seriously, a memorial to Congress is the proper way to begin work, and I hope it will not stop with the discussion of this paper."

H. L. Des Anges believed that if a standard system could be devised for small units, it certainly ought to be extended to large units. The success of the application of such a system had been pointed out by Mr. DuBosque, and he believed that the trend of progress was in that direction. In the locomotive field the same difference existed some years ago as exist now in the marine field, and no doubt the same objections were then raised to standardization.

Col. Edwin A. Stevens said that in association with Mr. Forbes he had had in the past some correspondence and interviews with officials of the Bureau of Steam Engineering with a view to making the most important working parts of torpedo boat engines interchangeable. The difficulty at that time arose from the fact that there was no appropriation that could be used to fix the standard. If the connecting rods, piston rods, and shafts of a lot of torpedo boats, built under the same general requirements of law, were to be standardized, the dimensions, threads, diameters, distance of centers, etc., would require a set of gauges, which would be at least expensive. In building ten torpedo boats there would probably be some sixty-odd connecting rods and piston rods, and it would strike the ordinary manufacturer as a good investment to get his jigs and gauges ready and to build these parts interchangeably. If, as the Secretary suggested, the matter could be placed forcibly before Congress so that an appropriation would be available, there was no question that one item of standardization of parts of torpedo boats could be readily carried out. It seemed to the speaker that on account of the number of break downs in that type of craft, the standardization of such engine parts was as desirable as the standardization of electric units or pumps.

Walter M. McFarland said he did not agree with the suggestions of having the work done by the Navy Department or by memorial to Congress. It would hardly be possible by Act of Congress to compel manufacturers to agree on any standard. It would have to be a matter of mutual concession. A very much better way, the speaker believed, would be by the appointment of a suitable committee of the Society to take up the subject first and consider it on broad lines. It would be possible then to map out the best way to accomplish this work, and to get an agreement on something, even if it were only a few auxiliaries. If that much work could be done, it would be a help to others, and he believed that rapid progress could be made if the matter were taken up by a suitable committee composed of men of a conciliatory disposition, and at the same time with a firm purpose to carry the matter through.

"We would not want anybody who was a doctrinnaire, or who had fixed ideas of what was to be done, but a man who was willing to hear the other side, and concede something himself. Have a committee composed of men of that sort, and I believe that in the course of a couple of years they would be able to bring forward a scheme which would meet with general approval on the part of the manufacturers, and if we found by that time that we had enough agreement to go to Congress, and to go to the Navy Department, and ask them to help the work along, I think we would be in good shape to do it. But if we start in the Navy Department, they, not knowing all the manufacturers peculiar features of equipment, might get up a system that would not fit in at all. Of course, they would consult the manufacturers. But if the committee should be composed of manufacturers, then we would have the very men who would know every point, and who could handle the subject very much better than people who are not."

E. Platt Stratton suggested as a first subject the determination of the thickness of flanges and the number of bolts for certain sizes of pipe. When this was agreed upon it would be easy for the representative sof the Society to arrive at a standard fitting, and after its adoption by the Society the classification associations could make use of it in their drawings. In this way the standards would be published far and wide, and would be within the reach of all manufacturers and engineers engaged in marine construction.

Francis T. Bowles inquired: "Would not the classification societies move in this matter initially acting acting under the advice of the Society?"

Mr. Stratton, in reply, said that the purpose of the classification societies was often misunderstood. They are the intermediary between the banker, the merchant, the shipowner, and the shipbuilder, and represent the capital side very largely of the operations in ships. They seldom take up anything more than necessity required. As they existed by no written law or operated under no written law except that of commerce and trade, it would be rather outside of their functions to dictate as to what sizes should be used as a standard.

W. D. Forbes said that it would be very difficult to make standards that all would adhere to, unless a law were passed to kill people who did not adhere to them. At the present time we had twelve threads and thirteen threads on a half-inch bolt. He believed this cost the engineering world a great many thousand dollars annually, but they still kept on doing it. He believed that the way out of it was for the Government to demand certain standards so that those who wanted to sell apparatus to the Government would have to conform to these standards.

President Clement A. Griscom, in the chair, said that the subject was of particular interest to the shipowner. "We all try in our individual way to standardize everything possible and suceed to some extent. In our place we carry a large stock of spares which are interchangeable over a number of ships. When we design a new ship we try to adapt ourselves to what we already have in the way of standards. But the subject is a great deal broader than can possibly be carried out by individual practice, and I think the Society will have to let it lie over until it formulates some practical way of solving the question. I agree with Mr. Forbes that the Government should be a mother in this case and take all the tribulation, and tell us how to do it."

Naval Constructor Joseph H. Linnard moved for the appointment of a committee of five to consider the whole subject of attaining the desired result of interchangeability of units, the committee to report at the next annual meeting any result that might be arrived at as to the proper method of accomplishing the end sought.

This motion was unanimously carried.

PERFORMANCE OF THE IMPERIAL RUSSIAN CRUISER VARIAG.

BY CHARLES H. CRAMP.

Commenting upon the performance of the *Variag*, the Author in opening says: "This high performance was due to the most perfect adaptation of her form or model to the attainment of the extraordinary speed required; to the excellent performance of her engines and boilers, and, also, to the best and most equitable arrangement of structural appliances in her hull to secure the greatest strength with least weights, and to the fact that in her design every pound of weight was put where it would do the most good." The vessel attained a speed of 24 knots over a ten-knot course, with 18,000 I. H. P., and a speed of 23.25 knots was maintained for 12 consecutive hours with a mean of 16,000 I. H. P. For purposes of comparison the Author has furnished a table showing dimensions, horse power, armament, complement and weights of the I. R. C. *Variag*, U. S. S. *Minneapolis* and *Olympia*, H. M. S. *Terrible* and *Diadem*, Chilian Cruiser *Blanco Encalada* and Brazilian Cruiser *25 de Mayo*. Points in favor of the *Variag* to which the Author calls attention are: "(1) No speed trial has hitherto been required of 12 hours' duration under natural draft. (2) Nothing approximating the speed developed by the *Variag* has ever before been attained in any vessel, or required by any contract to be effected under natural draft." In the contract for the construction of the *Variag* it was stipulated that the speed of 23 knots for 12 hours might be attained in two runs of six

hours each, with an interval between to rest the fire and engine room forces. In the trial this clause was not availed of, and the run was made continuously over the period of twelve hours. The performance of the *Variag* under the conditions imposed cannot be taken by the U. S. Government as a standard, the Author suggests, if there is adherence to "the scale of statutory limitations of cost hitherto incorporated in acts of Congress authorizing naval vessels. The Russions, while making drastic requirements, were also willing to pay the price necessary to obtain what they wanted." Commenting on the figures given in the tables, which accompany the paper, the Author points out that the displacement of the *Variag* devoted to coal and ordnance is extraordinarily high, amounting in the case of coal to 12 per cent of the displacement at trial draft. While keeping the fixed weights at a minimum in the construction of the vessel, it was also necessary to meet the Russian requirement that the maximum stresses did not exceed 5 tons per sq. in. of material—this requirement was carried out with a considerable margin. A water tight test was also imposed, each compartment being filled with a head of water equal to that which would be due to the immersion of the vessel to the upper deck line. This test was carried out to the satisfaction of the Russian inspectors. On trial the vertical vibrations of the hull, at varying speeds, were, at the maximum, very small, and under most conditions practically imperceptible. The dimensions, etc., of the *Variag* are: Length, on load line, 419 ft., 6 in.; beam extreme, 52 ft.; trial draft, 19 ft., 6 in.; trial displacement, 6,465 tons; indicated horse power, 15,925; trial speed, 23.25 knots; duration of trial, 12 hours; coal capacity, 1,250 tons; coal on trial, 770 tons; battery, twelve 6 in. R. F., twelve 75 mm R. F., six 47 mm, and two 37 mm, and two field guns; complement, 580; type of boilers, Niclausse water tube; type of engine, four cylinder triple expansion; number of screws, 2; fixed weights of hull, boiler and engines, 4,706 tons.

DISCUSSION.

LEWIS NIXON said that the special interest of this paper lay in the fact that it contained some valuable data that would be of use in future designs. Most of the ships of this fast cruiser type that had been tried, especially abroad, had been tried on the measured mile, and, of course, there was a certain amount of jockeying in such trials. When a boat was tried, however, for a period of 12 hours it was absolutely impossible to follow out any jockeying at all. You had to get down to first principles, because the men had to fire the boilers and run the engines as if they expected to keep it up not only for 12 hours, but for 24 hours. Again, some of the data that had been accumulated was arrived at by means of what are called normal trial draughts. Such boats, after they had been appropriated by Congress to be of a certain displacement, were made so, but, really, in service they would average beyond that displacement; and a good many of the U. S. Naval vessels had been tried with weights insufficient to put them down to service conditions—the conditions under which the *Variag* was tried. The question of weight in this case was one where every advantage had been taken of the very best quality of material, such as the builders were able to get in the United States, and such material as, undoubtedly, enabled the American designer to go to greater length than the foreigner had been able to go up to this time. He believed, also, a large share of the success was attributable to the very careful study which had been given to the distribution of strains and the placing of material at such points as would do the most good. The *Variag*, he believed, had nowhere reached her limit speed. He was satisfied of this from the way she would answer a sudden increase of power, as she went over the course.

NAVAL CONSTRUCTOR FRANCIS T. BOWLES said that they all joined in thanking Mr. Cramp for laying before the Society the performance of the *Variag*, and the results were sufficient to awaken anyone to enthusiasm. Mr. Nixon had called attention to the information contained in the paper, which, he said, would be of use in designing, and that led the speaker to express the only thought he had in looking over the paper, "that for searchers for information the data is a little meagre." He said that they were accustomed to get more information in their papers than had been given in this instance, and he sincerely hoped that Mr. Cramp would see fit to add a complete set of plans and further data in detail.

THE UNITED STATES EXPERIMENTAL MODEL BASIN.

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

In this paper the Author gives information concerning details of operation and results obtained at the Washington tank which have not appeared in previous general descriptions of this experimental station. The paper is accompanied by many dimensioned drawings, plotted results of experiments, and photographs showing the various appliances used in the construction of models and in recording the experimental data. In commencement, the Author refers to the plans of the basin, which is located in the U. S. Navy Yard at Washington, D. C., close to the eastern branch of the Potomac River. The difficulties met with in the construction of the station, due chiefly to the presence of quicksand, have apparently been overcome, as there has been no trouble from leakage or settling. The basin has a capacity of about 1,000,000 gallons, and is filled with water from the city water supply. Before it reaches the basin this water is treated with alum which coagulates with any mud present, and it is then clarified by passing through a sand filter of the pressure type. The operation of filling occupies usually about a week. After filling the basin a small stream is kept constantly running through the filters to freshen the water and for make up. A 12 in. electrically driven centrifugal pump can drain the basin in 4 hours. Other pumps are fitted including a 4 in. centrifugal connected with troughs on each side of the basin at the surface, by which the water can be "scummed." A constant temperature slightly above that of a living room is maintained inside the station, so that persons on the moving carriage do not suffer any inconvenience when moved back and forth in the moist air. Wave disturbances, in operation are rapidly absorbed by the side troughs, and by a wooden wave breaker at one end

of the station. This permits trials to be run with comparatively short waits between each. The traveling carriage complete weighs 70,000 lb., and the maximum speed is about 20 knots, and this is developed in a run of about 200 ft. The Author gives an account of the method of electric speed controlling and of the hydraulic braking apparatus employed. With a pressure of 300 lb. per sq. in. the hydraulic friction brakes can bring the carriage to rest from maximum speed within less than 20 ft. The emergency brake on the principle of the hydraulic recoil brake for heavy guns, has never been tested, the other methods of braking being quite adequate. On account of the high summer temperature in Washington paraffin could not be used for models. White pine is used, and the Author makes a comparison between both substances, showing that on the whole wood is preferable. An advantage in its use was the possibility of using longer models than at foreign tanks. A model 20 ft. long is used. It was found that for the 20 ft. models of practically all the U. S. naval vessels, the resistances at the speeds corresponding to the actual maximum speeds of the vessels were below 40 lb., while with 12 ft. models the resistances would have been below 9 lb. With the large model the gap between model and full sized ship to be bridged by the law of comparison is less. In practice resistance curves are determined for each model of a warship, each extending somewhat beyond the speed corresponding to the maximum speed of the proposed vessel. In brief these curves are: (1) with a model corresponding to the normal displacement and trim, (2) the same model trimmed 4 in. by the head, (3) the same model trimmed 4 in. by the stern, (4) the same model 10 per cent lighter, (5) the same model 10 per cent heavier. In the drawings accompanying the paper the five curves for a model representing the U. S. S. *Yorktown* are plotted. The maximum speed of this vessel at 1,680 tons was 16.7 knots, and the corresponding speed of the model 4.93 knots. The Author directs attention to the plate showing curves of changes in level in the 20 ft. model when in motion. The net result of these changes is that the center of the model invariably settles when under way. As the speed increases the rate of settlement may diminish and a tendency to rise again may be developed, but in no case has this tendency been strong enough at maximum speed to really restore the center of the model to its original level. The fact, however, that a model at speed settles bodily with reference to its still water position does not necessarily imply greater immersion in the water, since the water level around the model is disturbed by the passage of the model. Results of experiments with models of the same weight, upon the same lines but with varying proportions of beam to draft go to strengthen the theory that length and displacement are the primary factors involved in resistance i. e., that given the length and displacement of vessels of usual forms, the resistance is not materially changed by practicable changes in shape, beam, draft, etc. To establish this theory, however, the Author says would require many additional experiments which it is hoped may be carried out in the future. An interesting result showing the practical (dollars and cents) value of the tank experiments in connection with observations on models of the *Georgia* class of battleships is referred to by the Author. These battleships will be among the largest and most powerful ever built or building for any navy. Experiment with different models of the proposed vessels showed that as between two particular models a slight change in shape and an increase in length gave a vessel which would attain the speed of 19 knots with 2,000 less horse power than the smaller vessel. The longer ship had about 4 per cent greater displacement than the other and yet gave the required speed on 19,000 I. H. P., as against 21,000 I. H. P. necessary to attain the same speed with the shorter vessel. Speed can be obtained by increase of length, the Author points out, but great length is objectionable in a battleship, involving, on a given displacement, heavier rudder gear for the same manœuvering capacity, a larger target, a greater weight of hull for the same strength, a greater weight of armor for the same percentage of protected area and usually somewhat greater power at the cruising speed of 10 knots. Therefore to determine by actual experiment the "necessary and sufficient length" of the proposed new ships was an achievement which would not have been possible but for the existence of the Washington experimental basin. Included in the paper are appendices containing details of the preparation of the models and a description of the recording dynamometer employed.

In the absence of the Author of this paper, it was read by Naval Constructor Washington L. Capps.

DISCUSSION.

After the reading of the paper had been concluded, ex-Engineer-in-Chief Charles H. Loring, U. S. N., who had been called to the chair, announced that it was open for discussion.

PROF. WILLIAM F. DURAND: "I wish to register my high appreciation of the extent of the information which has been given us in this paper, regarding the equipment of the Government tank at Washington, and of the very full manner in which the information so far available has been placed before us regarding the plant, which has been made ready for the purposes of experimental investigation. I am, perhaps, especially able to appreciate the work that has been done there, from the fact that during the past year or two I have myself been engaged in designing and building apparatus for carrying on similar work, although in a vastly more limited way. But I have had these problems forced upon me, and so have been concerned with attempting their solution, and this also somewhat on a more limited scale. One cannot help but admire the possibilities which are placed before the constructors of the Navy and the country at large by this magnificent equipment, and I wish again to register my high appreciation of the manner in which the design of the apparatus has been carried out, and its construction, and the careful way in which the various possibilities of the future have been provided for. I am sure that we as a nation ought to feel gratified that this plant has been provided, and that it has been placed in Washington in the charge of those in whom we may have perfect faith that they will be able to carry it on to its ultimate purpose, and that

finally the Department is so minded that it is willing to give out this extensive, exhaustive description of the plant and apparatus. I am sure we may confidentally hope that as the years go by we shall receive from this source of information a vast amount of facts which will be of the greatest aid, not only to designers of war ships and naval machinery, but to designers of mercantile machinery and to the country at large, and I am very sure that to the country at large the investment which the Government saw fit to make some few years ago for the establishment of this plant will be many, many times repaid."

Frank B. King said there were two or three matters which he believed were of very general interest in connection with the tank. He would like to have some information in regard to the outlook for the use of the tank by merchant shipbuilders or shipowners who were anxious to know something about the probable performance of ships of unusual design. He believed that, in connection with the Appropriation bill under which the tank was built, the Secretary of the Navy was authorized, in his discretion, to permit the use of the tank for private experiment. It would be of interest if Mr. Taylor would append to his paper a statement of the conditions under the which the tank might be used.

"The merchant shipbuilder is very often confronted with a vessel of unusual design," said Mr. King, "and he has to make propositions on vessels of unusual type at sometimes quite limited notice. Probably he will receive a communication in the morning, and he must have his general conclusions formed in regard to the possibility of attaining a certain speed in a vessel of unusual form or dimensions, and send off a proposal during that same day. Under these circumstances, it is almost impossible to properly estinate the power and the cost of the machinery, or of the modifications of dimensions which it would be most advantageous to make. It appears to me that this tank could be used, if there were time to permit it, outsde of the experiments carried on by the Government, to carry out a series of experiments on standard models of various dimensions, and preferably, I think, of extreme types or dimensions, from which, by Froude's law and the formulas that go with it, we could—having, say, 100 standard experiments to draw from—forecast with reasonable clearness, the probable performance of any vessel of extreme type."

Naval Constructor Joseph H. Linnard said that the Author of the paper, with characteristic modesty, had omitted to call the attention of the Society to the vast amount of original design and work involved in the model tank at Washington. He had the pleasure of following Mr. Taylor's ideas to an extent in the course of their conception and execution, and those who had made a study of the methods and equipment of foreign tanks had been struck by the fact that about the only thing common to the station at Washington and the foreign experimental stations was the fact that it contained a tank full of water. All the rest of the apparatus, was, he believed, absolutely original in design, and much more effective for accuracy, for power, and for rapidity of results to anything that had been accomplished abroad.

James Young, in a communication which was read at the meeting, said he found a lack of agreement in the statements made by the Author that "given the length and displacement of vessels of usual forms, the resistance is not materially changed by practicable changes in shape, beam, draft, etc.," and the statement, "our battleships, on account of the necessity for giving them shallow draught and rather full forms, are essentially harder to drive than the deeper draught foreign battleships of about the same displacement." If the first statement were correct, it would appear as if there were little use of an experimental tank. The case of the foreign battleship being easier to drive, due to the deeper draught, as the Author had mentioned, would show that her draught and form had something to do with her resistance, and this seemed to be explained by the fact that her prismatic coefficient was thereby reduced; or, in other words, that her length of entrance (by Kirk's analysis) was increased. This, he believed, played an important part in the resistance of ships, and if the Author had confined himself to the statement that "the length and displacement are important factors involved in the resistance of vessels," the writer would be thoroughly in accord with him. Mr. Young then outlined an arbitrary method which he had devised for determining the necessary I. H. P. required to propel a vessel at a given speed, "without any pretense of the true theory of the subject." He had been led to consider this matter by an investigation of the formula put forward by John Thom, published in the *Transactions of the Institution of Engineers and Shipbuilders in Scotland*, and he had endeavored to improve upon Mr. Thom's formula, by taking account of other factors and ratios of the vessel's form which had not been considered by Mr. Thom.

Naval Constructor W. L. Capps, in responding for the author of the paper, said that when the appropriation was made for the model tank, it was distinctly understood that, as opportunity offered, experiments with merchant vessels would be undertaken, but, as Mr. Taylor had stated, the staff was very much occupied with government work and that work would, undoubtedly, take precedence for some time to come. It was most probable, however, that the data derived from experiments with the government models would be at the disposition of the private shipyards, and in that way they would derive all the benefits from the work done. He did not think that it was at all possible that, when a question, such as Mr. King suggested, had to be answered in a few hours, it would be possible to supply any satisfactory experiments which would enable the estimator to complete his figures within twenty-four hours. The work on standard models would be carried out as far as possible as opportunity offered. Mr. Taylor had already started in this direction by expanding the U. S. S. *Yorktown* in various ways, to see what would be the result of a change in length, breadth and draught. He would like to add his own testimony to that of others as to the extreme value of the paper, and could state from personal experience that some of the matters contained in it, as derived from model experiments, were fully demonstrated in the full-sized vessels. With a bat-

tleship at seventeen and eighteen knots speed there was a very distinct settling at the stern and lifting at the bow, and with torpedo boats going at thirty knots, the change was even so great that you could see daylight between the keel forward and the water, and the level at the stern was some times just about level with the water forty feet away from the vessel. Undoubtedly, next year and in succeeding years, there would be much more valuable data to present to the Society, and, in time, he believed that the results would give the same sort of data that would be secured were merchant ships being tested in the tank.

John C. Kafer referred to the experiments of Mr. Froude with the first model tank, and recalled an incident which occurred in the presence of Mr. Froude. After that scientist had been discussing the resistance of ships, one of his audience got up and narrated an instance of a ship having been lengthened, to carry six hundred tons more without increasing the resistance. In general, whenever a ship was lengthened the machinery was renewed and the economy was in the engine power. But in this case the machinery had not been altered at all, though the ship had been lengthened, and it was found that it did not require any more power to drive that ship at a certain speed than before the alterations, and yet she carried six hundred tons more freight. This had led Mr. Froude to make experiments with a model representing a ship 520 feet in length. This model was in sections and was towed in the tank, first entire, and then after sections representing 20 feet of length had been removed one at a time. Mr. Froude then found that the curve of resistance went up and down, verifying the results met with in the ship which had been lengthened. The true cause of this curious condition was not learned until some instantaneous photographs were made of the water. Then it was found that the wave generated by the bow of the ship was constant; that is, the ship's bow would generate a wave and a half. In one case, the ship took advantage of the crest of the wave being under the counter; but, in the other case, the hollow of the wave was under the counter. The speaker believed that Mr. Froude had gone into the matter rather exhaustively before he died, but yet had never been able to definitely say how long a ship should be made, or by what means the proper length could be determined for a given speed. He mentioned this little incident in connection with the experience of Mr. Taylor with the models of the *Georgia* class. He then referred to the tank in the ship yard at Dumbarton on the Clyde, which was the only tank in a private yard. He understood that the owners of the tank had on one occasion a contract for building an Australian steamship. They had been asked to build a ship from the drawings of a ship already in existence. They made a model of the proposed vessel, towed it in the tank and afterward mode certain changes in the model which brought down the horse power considerably, while carrying the same weight of freight and the same number of passengers, having, in fact, identical accommodations. The result of the experiment was a very large saving in cost of construction to the firm.

Second Technical Session.

Ex-Engineer-in-Chief Charles H. Loring, U. S. N., was in the chair when the members were called to order at 2:25 o'clock in the afternoon, and he announced the reading of the next paper on the programme.

THE COMPOSITION AND CLASSIFICATION OF PAINTS AND VARNISHES.

BY PROF. A. H. SABIN.

The limitations of chemical analysis as applied in general to paints and varnishes are noted by the Author by way of preface. A paint consists of a solid substance, a "pigment," mixed with a liquid which in the liquid state is termed the "vehicle" and when dry the "binder." The only white pigments are white lead and white zinc. "The simplest test of white lead is to put a little of it on a piece of charcoal and heat it in the reducing flame of a blow pipe; it will be converted into metallic lead and there will be no white residue." As little over 10 per cent adulteration may be proved in this way, the test for lime is more elaborate. Other common adulterants are barytes or barium sulphate, kaolin or white clay, whiting or pulverized chalk and silica. Of these, whiting, carbonate of lime, is alkaline and "should never be allowed in oil or varnish paints." Black pigments include lamp black and bone black—otherwise known as drop black and ivory black—and graphite. Lamp black is sold in various grades of fineness. It contains a peculiar oily matter and retards the drying of oil more than any other pigment but is the most durable paint. Red pigments include vermilion and carmine. Vermilion is a sulphide of mercury, of beautiful color and tolerably permanent. Carmine is an organic compound of alumina, is rather transparent, and is used as a finishing color. Coal tar dyes also furnish some red colors. Various iron oxides form the ordinary brownish-red and brown pigments; some are of a purple shade and all are deep in color and have great opacity. Many oxide pigments are made from ores containing clays, which make them brown, or, in the case of ochres, yellow. Sienna, used for staining wood mahogany color, is an earthy oxide. Chromate of lead, the most common yellow pigment, is made, in the paler shades, by the addition of sulphate of lead at the time of making the chromate. Pure orange chromate of lead is made by the addition of a solution of bichromate of potash to a solution of nitrate or acetate of lead. Cadmium yellow and ochre are two other yellow pigments. Chrome green is a compound of prussian blue and chromate of lead, and fades badly. Paris green is an arsenical compound of copper, brilliant but not opaque. Chrome oxide makes a subdued and permanent olive green. Prussian blue is a ferro-cyanide of iron, but the most common blue is ultramarine, a secret preparation. Cobalt blue is the most permanent, but too high priced for ordinary use. The foregoing are the principal opaque body colors, and there is in addition a class known as "lakes," made by precipitating the color ingredients of various dyestuffs with suitable chemicals. These lakes are commonly used to impart a tone to the more opaque pigments. Vehicles are next discussed by the Author. Linseed oil is the principal oil used, and

is made by expression from flaxseed "Crude oil" is allowed to settle in tanks and when clear is drawn off as " raw oil." "Boiled oil" is made by heating a portion of raw oil with lead and manganese oxides until union occurs, and then this is added to a large quantity of raw oil. Linseed oil, when spread in a thin film, absorbs and combines with oxygen from the air and is converted into a somewhat elastic, leathery substance known as linoxyn. "Dryers" are compounds of lead and manganese in solution in oil, and these metals when in linseed oil give up half their oxygen to the oil, and when exposed to the air—when the oil is spread out in a film—they absorb a fresh equivalent of oxygen, which again the oil takes from them, until finally the oil is converted into a solid, dry substance—hence the name dryers. Dryers are often cheapened by the use of resin or resin oil instead of linseed oil. "Japan" the Author defines as a substance which promotes the drying of a paint film. Dryers and japan shade into one another and what one now would call dryers another would call japan. In common acceptance japan is a liquid which by itself, dries to a hard film, and it often contains varnish resins. Another class of preparations termed japan includes varnishes that are fused on the surface of metals by subjecting the coated article to the heat of an oven. Cheap paints receive a share of the Author's attention. In these fish oil and mineral oil are often mixed with the linseed oil. Lime water, a solution of glue, and a solution of silicate of soda are also often used as adulterants. "Fire proof paints" are made by grinding into each gallon of paint about a pound of boric acid or a very soft and fusible glass, powdered. When the paint is exposed to heat the acid or glass will melt and form an air proof protective glaze over the painted surface. Most all oil paints contain turpentine, benzine or other volatile solvent. Kerosene is used as a substitute for turpentine, but should be avoided. "Varnishes" are divided into two classes: Spirit varnishes, including what are called "lacquers;" and oil-dried resin (also called oil-dried gum) varnishes. They are used as perservative and ornamental coatings by themselves, and also as vehicles with pigments making varnish paints or varnish enamels. A spirit varnish consists essentially in a solid substance dissolved in a volatile solvent, and when spread in a film the solvent evaporates and the permanent part is left as an enduring film. Spirit varnishes are made usually by dissolving shellac, or fossil resins in alcohol. "Compositions for ships' bottoms" are taken up by the Author at some length. These are made by dissolving coarse New Zealand resin in a mixture of coal tar, naphtha and benzine, and with this is mixed the pigment, which may contain piosonous matter, to make it an anti-fouling coating. A list of patents issued for ships' bottom paints is given by the Author, together with a chronological table of the application of various materials to this purpose. Bottom paints he classes as anti-corrosive and anti-fouling. The latter depend for their effectiveness upon some substance which will poison marine growths, such as oxides of copper, arsenical or mercury compounds. Discussing the use of these poisons, the Author states that the common practice has been to use mineral poisons; but in the end, organic poisons may prove more suitable. Oil paints have been used for ships' bottoms, but have not been satisfactory on account of the perishable nature of oil films in sea water Coating materials containing asphaltum in a volatile solvent are also touched upon. Oil-dried resin varnishes are considered at much length in the paper. These are made by dissolving vegetable resins in linseed oil, both being heated to a high temperature during the process. Varnishes of this class are also made by using asphaltum instead of resin, and these are especially adapted for use as baking japans or "enamels." Such enamels can be made without dryers and of the most refractory materials such as will resist any ordinary chemical action at high tempeatures. The Author believes that a properly made baked coating is superior to all others. "Red lead" is also considered in detail. It is a mixture of the peroxide and the protoxide of led, and is used as a paint, chiefly on iron and steel, to prevent corrosion. The most common adulterant is iron oxide. Its readiness to unite with other chemical substances make it, if directly exposed to the air or water, easily attacked, particularly by carbonic or sulphurous gases. The Author is of opinion that where red lead is used it should be with a maximum of lead to the given amount of oil, and that it should be used only as a first coat, being protected by two outer coats of some impervious paint or varnish. Attention is given by the Author to the common belief that varnishes are not suited to exterior use, for protection against the weather, whereas he shows that varnishes poperly made and properly applied are most effective for outside use. A varnish film is very much less porous than an oil film. The compound of oil and resin is far more indifferent to chemical action than oil alone. It also possesses a high degree of elasticity, and in this respect is vastly superior to a spirit varnish film which, when spread, is very brittle. For marine exposures the Author's experiments have conclusively shown that varnishes and varnish paints are greatly superior to oil paints or red lead, while the baked enamels are much better than either. "Fillers" are next considered, the Author expressing a preference for paste fillers over liquid fillers. In conclusion, the Author, as a result of his experiments, finds that in general there is no great difference in the value of pigments in either oil or varnish paints The thing most important is to have them ground fine—the finer the better. "The best pigment is a neutral, permanent, unchangeable substance, ground to the last degree of fineness, and mixed with the vehicle, whether oil or varnish, by grinding the mixture through a stone mill."

DISCUSSION.

Bernard F. O'Connor, referring to the statement contained in the paper about paints for ships' bottoms, said that the point made by Professor Sabin regarding the ineffectiveness of oil paints on steel bottoms was not as well known among shipowners, especially those of the older class, as it should be. There was one point, however, upon which he disagreed with the Author of the paper. Professor Sabin had said that oil paints ,especially red lead and zinc, were a good foundation for what he termed varnish paints. In another part of the paper, however, the Author

said that nearly all of those so-called varnish paints had their own chemical affinities, and that some of them had a strong disinclination to affiliate with oil or oil paints, or that they might affiliate too closely and take the whole film off the ship's bottom. This was in connection with putting what are known as patent paints over red lead. In addition to the poisonous paints used for ships' bottoms, which the Author had mentioned, there was another class of paint in use in which the composition was such that, instead of poisoning the marine growths, it permitted them to catch hold of the surface, and then the first time that the vessel moved, the skin friction was sufficient to take off the growths—a sort of flowering paint. If this kind of anti-fouling paint could be made successful so that enough of it would remain on the ship to flower all over slowly, say for a year or two, it might solve the question. A curiosity of bottom paints was that the same paint on the same work would not act twice in the same way. This was due no doubt to the change of the chemical elements of the water in which the vessel might be, for as the Author had pointed out, sea water was a great solvent and a chemical agent of unknown but great power.

Professor Cecil H. Peabody inquired whether it could be definitely stated that the materials put in bottom paints, such as oxide of iron, copper and mercury, either one, or any, or all of them, were known to have a deletrious effect in promoting corrosion. Professor Loomis, who had investigated the subject, had dwelt specially on this point and was distinctly opposed to the use of copper in any bottom paints. He would also like to inquire whether the newer methods of making white lead gave a different product when finished and one less durable than lead made by the old process. He had been informed by painters that white lead made by the newer processes was likely to contain chemicals which acted upon the oil, and, therefore, the paint was less durable.

Prof. Sabin: "In regard to the matter of the action of the oxide in the metallic paint in the paint on a ships' bottom, it has been claimed that the use of powdered zinc is very advantageous, as it is well known that the zinc protects the iron as long as there is any zinc there. That is undoubtedly true so far as it goes. But as regards the action of the copper upon the bottom of the ship, I know that Prof. Loomis and others have objected to the use of copper in those paints. I am not myself a believer in copper paints, but I do not believer that there is any such action as he apprehended, because the varnish which is used is a perfect non-conductor, and as long as the varnish lasts it protects the paint, and as fast as the varnish goes off the copper drops off. That is the theory, and as a matter of experiment I do not believe it has ever been shown that copper paint does injuriously affect the bottom. That is my opinion in reagrd to the matter, and I have looked into it a good deal. It is the same thing with mercury. Mercury and iron do not have any affinities at all. We always distil mercury in an iron bottle, a metallic bottle, and even when it is so hot as to be in a state of vapor it has no action on the iron whatever, and I do not believe that mercury compounds affect the metal a bit. As to the white lead question, I believe that nine-tenths, perhaps ninety-five hundredths, of the white lead that is made to-day is made by the old Dutch process. There are one or two manufacturers who are making a different product and have got it on the market, of course, and you can buy it, and I do not know but that it is just as good. If have no reason to suppose that white lead is not just as good as it used to be. Of course, a painter always has an excuse for a paint not lasting. There is absolutely nothing more widely and uniformly distributed among mankind than the disposition to lay off the failure of anything on to your neighbor. I am not interested in the slightest degree in the white lead business, or any other pigment business, but that is my opinion, that the lead is practically just the same as it always was."

Prof. Peabody: "Can you kindly say what is your objection to copper? You say it probably has no effect on the plate. I don't know that that was mentioned in the paper."

Prof. Sabin: "No, it was not. I did not say officially. So far as I have been able to learn, it is not efficient; that is all. If it was efficient I would be in favor of it."

Prof. Peabody: "What would be more efficient?"

Prof. Sabin: "Well, I don't know."

Samuel L. Moore: "What makes the white lead fail? You say it is as good as it ever was."

Prof. Sabin: "Well, I can tell you. The principal thing that makes white lead fail is that they do not use oil with it. White lead will take less oil than any other pigment. Ordinary white lead is sold in a paste which contains ten pounds of linseed oil and ninety pounds of dry white lead. That is the regular standard formula. Now, there is no other pigment which you can make a paste of with oil, without taking at least twice as much oil as that and usually more. To make an ordinary paint, that is, paint thinned down to the ordinary consistency with white lead, you take less oil than you do with any other pigment. The painter wants his paint to dry very quickly. If he puts a lot of dryer into it—he always puts in some—he is sure to darken the color and yellow the paint. Now, the beauty of white lead is that it is white,, and so that instead of putting a dryer in, which I do not believe in, anyway, he puts in turpentine; he thins down his paint with turpentine, and the result is that the turpentine evaporates, and in his film he hasn't got enough binder, he hasn't got enough cementing material there to hold that lead together, and it just comes off. If he would use straight oil the paint would not dry quite so quickly, but it would be durable, and that is the primary and fundamental objection to this whole white lead business; it is because the painter uses turpentine to thin down with, instead of oil."

Mr. Moore: "Supposing a man buys white lead and boiled oil, and mixes them himself, it doesn't last any better."

Prof. Sabin: "He ought to get good results. Some years ago we were selling a lot of dryer to a man who was making an artificial linseed oil, what he called 'Cuban linseed oil.' He went into bankruptcy and I had occasion to go through his books, and I

found the secrets of the trade. He was making that oil out of what is termed 'neutral,' which is a product sold by the Standard Oil Company. It was sold at that time for twelve and a half cents a gallon. It is an oil of about the same consistency and color as linseed oil. He loaded that stuff up with resin and dryers. It is an astonishing thing, but it did dry quite a good deal. Now he did not sell that oil to the consumer, but he sold it in carload lots to the jobbers, big people, with first-class business reputations, and that oil went into boiled linseed oil. It did not go into raw oil, because it was full of dryers. Now, there is a lot of adulterated boiled oil sold in the market, so much so that we have now got stringent laws in this state against it, and the State Commissioner of Agriculture has employed a chemist and is going at this thing to try to put a stop to it if possible. But it is extremely common. The extent to which adulteration is carried out is something which anybody who is not in the trade can have no idea of."

Mr. Moore said that he was acquainted with a man in the paint business who used three ingredients—water, oil and sugar of lead. He believed that in this case the sugar of lead was used to make the water and oil mix. In his own experience he had found that you could mix linseed oil and water in ordinary paint and they would not separate.

Prof. Sabin said that the sugar of lead used in the mixture referred to was used probably as a dryer, but it was not likely that much of this chemical would be used, as it was very expensive. The paintmaker referred to probably used a great deal of water. By the use of lime water, dilute soda solution, or borax and water, a mixture with oil and pigment could be made and many of the mixed paints sold were manufactured in this way. "You can run right along down all the way from a pure linseed oil paint to a kalsomine. Kalsomine does not contain any oil."

George M. Gardiner: "I would like to supplement a little what Prof. Sabin said in reference to copper in paints. I have probably had as much experience in these matters as anyone else, having been the original introducer of copper paint for wooden vessels in this country. Of course, copper in the way that we manufacture it for copper paints, and copper oxide pulverized, would not do to come in contact with the iron or steel. It was manufactured in those days simply for wooden vessels to prevent fouling, and especially prevent attack by the teredo, and it was very efficacious, so much so that insurance companies, on short voyages, would insure wooden vessels coated with copper paint on the same terms that they would a vessel with a metal bottom. That composition would not do on iron, except when it had some material between to protect the iron from the action of the copper paint. It became necessary, as the building of iron ships increased, to have a composition that would not only preserve the vessel from fouling and protect the iron surface from oxidation, but would also be a smooth coating. I devoted a great deal of attention some years ago to coating the bottoms of yachts to see how I could get the greatest amount of speed out of them, first, as a sort of fad, and then as regular practice, but I found the English people had gotten rather ahead of me, and were making a soap paint that exfoliated and in a measure hermetically sealed the iron or steel under it, and gave very excellent results. As to the copper attacking the iron or steel in any way, I would say that recently I examined a ship for some of the underwriters' agents here in New York, a ship that had been coated in this way for some twenty-six years, and the hammer marks on the rivets were as plainly discernible as if she were a new ship. The butts were all intact, showing absolutely no deterioration whatever. I have experimented extensively with all the poisonous compositions, the metallic oxides and some of the organic poisons, most of them, and I have examined in my time something over fifteen thousand vessels, and the difficulty in having any literature on the matter has been the difficulty in experimenting properly, the difficulty of getting hold of ships that had been coated and seeing them when they are docked. They are docked, of course, without any warning, and it is not possible to examine them and see them painted, and then have a vessel go away again and see it when it comes back, have it make various voyages to different parts of the world and of different durations, and all that sort of thing. Most of the people who have been interested in the subject have had a composition of their own, and all the benefits they could get from their experience they wanted to use in a commercial way for their own profit, so that it has been very difficult to get any really authentic data as to the action of various compositions on vessels' bottoms. We have been obliged to simply get the different compositions made in different portions of the world and make practical tests with them as best we could. I have done that whereever it was possible for the past thirty-five years, and the best composition that we have found so far is the metallic soap. Varnish paints are more soluble in water, and affected by the friction, the attrition in passage through the water. In the case of torpedo boats that make great speed the compositions are washed off very rapidly indeed. I remember Captain Fremont telling me that by looking over the bow of the *Porter* when she was going at her top speed, he could see the paint disappear. She was coated five times, I think, in six or seven months. The mercury poisons are more readily dissolved, as the Author says, in the water, and they are very much more injurious than any of the other organic or mineral poisons, when used as paints on iron or steel, especially on steel. But it is a matter of a good deal of importance to get a composition that can be applied in all sorts of weather. A vessel goes into the dry dock, it is frequently necessary to paint it the same day. I have to-day a large steamer on a dry dock ready for the workmen at two o'clock, and she has got to be completed to-night, painted three coats and ready to go in the water to-morrow morning. A member has remarked that the same paint sometimes does not act in the same way. That results frequently from the manner in which the composition is applied and to the length of time that the vessel is in the water, where she goes, and all that sort of thing. The water varies in different parts of the globe. You may get in one place a water that contains certain con-

stituents and in another place altogether different constituents. You will find in the Mediterranean that the water is altogether different from the water outside, and that is one of the reasons for the apparent difference in the action of the different compositions in different waters."

NAVAL CONSTRUCTOR FRANCIS T. BOWLES: "There are certain things that everyone in the ship business knows about paints, and particularly about bottom paints. We know that they are all very expensive and none of them very good. Now, most of the knowledge upon this subject is confined to the people who manufacture the paints, and as you have seen to-day they keep that strictly to themselves. I had hoped that by the inducement of Prof. Sabin's very valuable paper these gentlemen representing the bottom paints would have been moved to give us a little more information. It is, however, necessary that this subject should be followed up in a systematic way, and I have some pleasure in telling you that Prof. Sabin is carrying on a systematic series of experiments which have already extended more than two years upon all kinds and varieties of paints, to their action in sea water, and if he persists in this investigation, which he undaubtedly will, then we shall in the course of a few years obtain certain actual facts which will lead to the improvement of bottom paints for steel vessels, a subject of the very greatest importance to us all."

MR. MOORE said that he had often noticed that the mill marks on plates which were put on with a mixture of white lead and turpentine never wore off. He believed that every man who had docked ships would agree with him that when a ship was hauled out and cleaned and scraped, the mill marks would be found on the plates. Even in the case of plates that had been pickled, he observed that these marks remained on. They were applied when the plates were hot.

H. L. DES ANGES narrated a similar experience. He had often in renewing plates on a vessel's side noticed that the original mill marks were still quite legible, while the rest of a plate was very badly corroded.

MR. MOORE related an experience with pulleys on which the size had been painted with either white lead and turpentine or lamp black and turpentine. These pulleys had stood out of doors for years, and when brought into the shop the markings could be easily wiped off, but the figures—the place that the paint had protected—stood right out in relief, while the surrounding metal had all rusted and pitted badly.

NAVAL CONSTRUCTOR LLOYD BANKSON, in written discussion, said that the French Naval Constructors held that galvanic action took place between lead paint and the steel hull of a vessel under water. He quoted Dr. Dudley of the Pennsylvania R. R. to the effect that "the most persistently active rust producing agents, carbonic acid and moisture, were generated in the drying of linseed oil; and, further, ordinary rust (hydrated oxide of iron often containing more or less carbonate of iron) is credited by chemists with imparting to the metallic iron immediately under it some of its oxygen and water, and replacing this loss from the atmosphere, or from any other available source, acting as a carrier of the necessary elements; 'rust begetting rust.'" According to the statement that carbonic acid and moisture are generated in the drying of linseed oil, it was quite possible that galvanic action set up between metallic paint and the surface of steel hull under water, which also set free, possibly, a certain amount of oxygen from the water. Those who had examined the bottoms of vessels in dry dock immediately after pumping out might have noticed blisters filled with water, with small rust spots underneath, showing probably incipient formation of pits. It was also possible that the spongy condition of any of the linseed oil paints would admit water at certain points between the coating of paint and the hull of the vessel. These conditions, he believed, would account in a great measure for the pitting of steel vessels. He then referred to torpedo boats built and building at the Bath Iron Works, on which a neutral paint known as "Zinc Gray" had been used to protect the hulls, and especially for protecting the aluminum, which was extensively used in certain parts of the hulls of the boats referred to. The torpedo boat *T. A. M. Craven* was painted entirely on the outside above the water line with a dark brown neutral varnish, and no criticism had been made in regard to the visibility of this boat so far as the color was concerned. This coating was lighter in weight than lead paint, and made a very efficient coating for all metal work above the water line, and for all metal work inside. In consequence of the apparent deleterious action of metallic paints, such as red lead, etc., on steel vessels below the water line outside, it was probable an excellent coating for ships' bottoms would be a first coat of a water tight neutral varnish, upon which might be laid a good, quick drying, anti-fouling paint. He believed that this was an experiment well worth trying.

TESTS OF THE ELECTRIC PLANTS OF THE BATTLESHIPS KEARSARGE & KENTUCKY.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U. S. N.

This paper is supplementary to the paper descriptive of the plants on these ships, which was prepared by the Author for the previous meeting of the Society. It consists of a series of plates, containing tabulated and graphic results, of exhaustive tests of the electrical plants of the two battleships built at the Newport News Yard. The text which accompanies these plates simply explains the results sought in each case, and the methods by which these results were obtained. The tests, which were nominally in charge of the Author, were carried out in his absence abroad by his assistant, J. J. Crain, M.E., who had charge of the work from its inception. In general the object of the tests was, first, to determine if all appliances used were properly constructed and installed, so that they could perform in a satisfactory manner the severest duty that would be required of them in actual service and, second, to collect quantitative data regarding the performance of these appliances. An auxiliary of each of the kinds installed was given a "type test" in which it was run under all possible conditions of load, speed, length of run, etc., and a record of all data obtained was made. This was followed by an "acceptance test" of all other auxiliaries of the same kind, which consisted of

only of such running as was necessary to show that the auxiliaries were operating in practically the same manner as the individual machine which had been given the more exhaustive type test. Any characteristic fault in design or construction would be developed in the type test, and in such case the test was discontinued until the fault was remedied. The acceptance tests developed any local faults of installation or material. The foregoing system was adopted for all motor driven auxiliaries, but for generating sets a different method was pursued. The object of the tests of generating sets was to demonstrate that each set would run satisfactorily for a continuous period of forty-eight hours, and to determine the total steam consumption of the electrical plant under varying conditions of load. In the endurance test the load consisted of the ship's lights and ventilating motors, and an adjustable water rheostat located on the upper deck. This rheostat was manipulated from the dynamo room and the load was kept constant on each generating set during the run. During twelve hours of each forty-eight hour run a boiler test was made on the auxiliary boiler used, and during six hours of each boiler test the engines were indicated and the output of the generators simultaneously measured. The general scheme for the determination of steam consumption was to measure the total water fed to the boiler, and then subtract from it the steam used to run the boiler feed pumps, the auxiliary condenser, air, and circulating pumps, the steam condensed in the steam piping, and that used by the calorimeter, the remainder being the steam consumed by the engines of the generating sets. The auxiliaries tested included those for operating the turrets, boat cranes, deck winches, ammunition hoists, elevators, blowers and exhausters. A summary of weights of the electric plant is also included. In ascertaining the weights the electrical appliances were separated from the mechanical parts operated by them—the motor pinion used was the dividing line. All gearing beyond the motor pinion was classed with mechanical parts, and the total weight of the electric outfit for each ship figured out 201.53 tons.

DISCUSSION.

J. W. Kellogg: "I would like to recall the discussion last year of the paper in which Mr. Woodward gave a description of those plants, and promised the results of tests for this year. At that time one turn the discussion took was the question of the economy of the electrical auxiliary and the steam consumption that could be expected from any auxiliaries, the average steam consumption, in comparison with the small steam engine. By taking the figures as given in this paper I find that the steam consumption of the generator set is 34 pounds per kilowatt output at full load; 37 pounds at three-quarter load, and 49 pounds at half load. The average efficiency of the motors is 75 to 80 per cent full load, and 69 to 74 per cent half load. The blowers, including the line loss, show 85 per cent efficiency. The blower load is the steady load, and is the one which is the most apt to be on, I think, of any of the auxiliaries where electricity is at present employed. Taking that efficiency and the steam consumption of the generating set, the consumption at the motor would be 30 pounds per horse-power at full load, and 33 pounds per horse-power at three-quarter load, and 43 1-2 pounds at half load. I think the statement last year was that the economy would be about 40 pounds as an average for all motor driven auxiliaries. I think that the results of this paper bear this statement out. I also wish to call attention to the pipe condensation as shown for the generating sets. It varies from 8 to 15 per cent of the steam used in the engines of the generating sets. I think the condensation in the piping throughout the ship, carrying steam to the other auxiliaries, would be about as large as this, and if it was added to the consumption of the ordinary steam engine—small engines driving the auxiliaries on a ship—the steam used per brake horse-power would be found to be at least double that of the average for electricity."

THE COALING OF THE U. S. S. MASSACHUSETTS AT SEA.

BY SPENCER MILLER.

This paper is supplementary to a paper entitled "Coaling Vessels at Sea," that was presented by the Author at the 1899 meeting of the Society, and in which he described the form of apparatus he had designed and which was then awaiting trial by the U. S. naval authorities. Since that time a practical test of the apparatus has been made in coaling the U. S. S. *Massachusetts* at sea. The apparatus tested is the same as that described a year ago, excepting the addition of an auxiliary or tension line above the conveyor lines, and a sea anchor attached to the end of this line. The dimensions of this sea anchor depend upon the speed at which the vessel coaling is moving. The apparatus had five trials. On the first day adjustments were made and nine loads passed between the collier *Marcellus* and the battleship. On the second day more adjustments were made and a run of 38 loads in 38 minutes and 40 seconds was suddenly terminated by lack of skill on the part of the operator. On the third day in one hour the apparatus transferred about 22 tons. The fourth trial was an endurance test of four hours. In 3 hours and 43 minutes 75 tons was handled. The water was smooth with a ground swell. In the fifth test—rough weather trial—80 trips were made in 80 minutes. In this trial one hour and a half was consumed in securing the tow line and setting up the apparatus. The boats steered at first head on to the sea. The forecastle of the *Massachusetts* was washed at every plunge, and no coal could have been delivered there even if desired. A little more than 20 tons were handled in an hour. The course was then changed, quartering on the sea, and the results were the same. Then the boats steered in the trough of the sea, and a rolling of 7 degrees did not affect the working. The speed was maintained at about 5 knots, and during the trial the *Massachusetts* burned about 3 1-2 tons of coal per hour. At 300 feet distance between the ships, even in smooth water, the collier followed badly, and when over 7 degrees out of her course the operation was stopped. In spite of stops, however, 20 tons per hour was delivered. During the rough weather trial, and with about 400 feet between the ships, the collier followed perfectly and no time was lost. In discussing possible improvements, the

Author suggests the use of a tension engine instead of a sea anchor, as in the case of the latter the strain on the line is very variable, due chiefly to the motion of the vessels in a seaway. Forty tons an hour could be readily loaded, he believes, by increasing the separate loads to 1,500 pounds. The paper closes with an excerpt from an article by Rear Admiral Royal B. Bradford, published in the *Forum*, in which that writer advances the self-evident proposition that coal is needed to enable steam war vessels to keep the sea.

DISCUSSION.

CAPTAIN CHARLES J. TRAIN, U. S. N.: "I am very glad to be present at this time, because I was not prejudiced, originally, in favor to towing this collier with the strange device of Mr. Miller, but the success of the invention was so great, everything turned out so well, that I am very glad to say that my prejudices were entirely removed. The towing of a ship by a man-of-war is always unpleasant. A towed ship means disaster and trouble and all that sort of thing. It never occurred to any of us—to me, certainly—that I could tow a ship at 300 feet distance, and run a trolley over it in twenty seconds from ship to ship with perfect certainty and accuracy, as we did. The coal came up that elevator on the collier with unexampled speed, hooked on the carriage, came over to the *Massachusetts*, and came down our hatchway with just as much certainty as it is carried in by the colored women down at Santa Lucia. Whether the suggestion of the English Admiral that the operating of machinery should be placed on the war ship is possible or not, I am not at all sure. The handling of these winches requires trained men and expert men. We have not got them on board ship and we cannot have them, and I am not at all in favor of fitting up battleships with such winches as those Mr. Miller requires, particularly the winch which is necessary to take the place of the sea anchor. Unquestionably the sea anchor was the key to the whole situation, not that I knew it before, because I did not know how far the art of carrying materials from place to place by means of trolleys had gone I had never heard of any such thing as a slipping drum. But the sea anchor made it advisable, and it required Mr. Miller's presence on board the *Marcellus* to see how the towed ship was constantly shooting from side to side and the difficulties in towing ships. So that without the sea anchor he never could have handled that trolley. That the sea anchor could have been replaced by a better device, I am perfectly confident, but that men-of-war could be so arranged I do not think is possible. We have already more machinery than we want, more machinery than we can handle with the men at our disposal, and I certainly believe that the colliers themselves should be fitted up with this contrivance, and that the American Navy should have 5,000 ton or 6,000 ton colliers fitted out with this contrivance by means of which they are independent of any coaling station, which, of course, are points of weakness that would only fall into the hands of the nearest strong navy. However, that is not material to the subject. All I want to say is that Mr. Miller's invention makes coaling at sea a perfectly feasible, simple, easy operation, which it never was before."

NAVAL CONSTRUCTOR FRANCIS T. BOWLES said: "I do not think it is safe for us to be always guided by the opinions of the English. I certainly hope that all the English battleships will have Mr. Miller's device, but I am equally hopeful that ours will not. Captain Train has put the matter very clearly, that we are already overloaded with machinery, and I can see that to carry this device on board a battleship would require a number of important changes in things that we now have located in more or less essential places. Our circumstances are somewhat different from those of the English, and it seems to me that we could afford to have colliers suitable in size and character for our work, fitted with devices for coaling at sea, and thereby have somewhat the advantage in the efficiency of our battleships."

NAVAL CONSTRUCTOR J. J. WOODWARD: "There is one point in connection with the installation of these special winches on colliers that I think is worthy of attention, and that is that quite apart from the manifest advantages of having special vessels fitted as colliers, ready at any time for service, has been really the perfection of the detail in the design of the winch. If we had these appliances at our Navy Yards, so that it would be simply necessary to place them on vessels suitable for carrying coal, the time required to install them on the colliers could be made very slight, indeed, provided always that the installation was on hand. The somewhat varied foreign policy that we at present have, the importance of having coal, and the means of getting coaling stations in an effective condition whenever we may be called upon to need them, gives to this general matter of coaling at sea a special importance. Any one who has had any experience in attempting to coal one vessel from another in a seaway, with two vessels alongside of each other, cannot fail, I think, to realize that the endeavor to coal in that manner is practically an impossibility."

SPENCER MILLER, in reply to the criticisms about adding to the complexity of the machinery already carried on war vessels, said that he hoped before long to devise some way of putting the necessary machinery on the war ship without adding anything to the complications. If he was unable to do this he would acknowledge that he was beaten.

Third Technical Session.

The meeting was brought to order on Friday morning, November 16, at 10:30 o'clock, by Charles H. Cramp, who occupied the chair. He called for the reading of the next paper.

NOTES ON RECENT IMPROVEMENTS IN FOREIGN SHIPBUILDING PLANTS.

BY ASSISTANT CONSTRUCTOR H. G. GILLMOR, U. S. N.

This paper is the result of personal observations made during visits to foreign yards during the years 1891-94 as compared with those made during recent visits in the years 1898-1900. The Author opens with the statement that "among foreign shipbuilders, as among other manufacturers with whom America is in competition, the impression seems to be general that American plants and American tools are as far in

advance as those of any country in the world. He refers to the fact that one shipbuilding plant looks very much like another, "at first sight," whether the plant be in America or England or elsewhere. "It is possible, in shipbuilding, to do with plant of value proportionately so small, as compared with the value of the product output, that often the plant is almost forgotton in the interest in the work being done." Most plants have developed from modest beginnings, their arrangements in the first instance being dictated by the character of the ground and the means at command. In expanding, the best results have been considered, but it is not always possible to use space to such advantage as would be the case were the plant originally laid out on an extensive scale. In many cases the increasing size of vessels has made rearrangement an absolute necessity, and in such case the work shops have been brought as near as practicable to the ships and an effort made to have material follow a regular course, with the minimum of handling. In connection with the arrangement of plants the author touches on the Trades Union question, which is "nowhere more to be seen than in the development of shipbuilding plants in England, and practically all the steel work is paid for by the piece, and the resistance of the Boiler Makers' Society (a combination of all steel and iron workers in the ship and boiler trades) to all reductions in piece prices is so great that it is impracticable to secure any adequate reducton in the labor costs from improved facilities." Improved facilities seldom give the builder even an increase of output, as broken time increases with every possible increase of earnings of the skilled labor. In the opinion of the Author, many English builders would have carried out extensive improvements had not conditions been such that no adequate return on the investment was possible. Trades Unionism is not so powerful in Germany, and partly for this reason, and because yards are newer, better arrangements and more labor saving appliances are to be found there. Next, the Author refers to the great waste of power in the average yard ten or twelve years ago, due to the extensive use then of isolated steam engines supplied from central boiler plants, and there have been extensive changes in this direction, largely in the direction of substituting for the steam plant gas and oil engines and electric motors. In one important yard steam has practically disappeared, except for hydraulic pumps and the yard locomotives. With gas engines, municipal gas, sold at a reduced rate, is frequently used, and in many cases Dowson or other fuel gas generated by similar processes is used. The engines employed are usually single cylinder, single acting, working on the Otto cycle. They are used generally for driving the machinery in the various shops, though not for direct driving of isolated machines. The gas engine is not adapted to the direct driving of the several heavy machines, subject to more or less intermittent working, which have a prominent place in the ship yard. For this reason extensive use is made of the electric drive. Dynamos of various types are employed, usually direct current machines working at about 110 volts. These supply current for both light and power, and are driven, in central stations, by both steam and gas engines, steam engines usually. Electric motors are extensively used for driving the heavy machines direct, and they stand hard service without failure, and usually have often no other protection from the weather than that afforded by a light wooden cover with perforated metal ends. The care of the motors and wiring is usually in the hands of men or apprentices who could not be classed as electrical experts. Hydraulic power is invariably used where large vessels are built, for heavy flanging machines, manhole presses, and cranes. With two notable exceptions there has been little recent improvement in appliances for handling materials in the shop. This is due to the reasons already mentioned, which make it impossible to reduce costs by the installation of labor saving devices. The old method of having wooden derricks along the sides of the building slips is usually adhered to, and light locomotive cranes for handling cars in the yard and for transporting heavy materials are frequently met with. Standard ship yard tools have not changed much except in size to handle the increased size of scantlings. In Germany the power bevelling machine (an English invention) is in general use, while in England the joggling machine is commonly met with. An ingenious plate scarphing machine, also new styles of plate drilling and countersinking machines, rolls and other tools, were noticed by the Author. In the fitting (machine) and joiner shops improved tools, many of American make, are numerous. In many yards much work which would be done in the fitting shops is let out to concerns making a specialty of such work. In the employment of portable tools at the ship very little has been done. Many portable electrical drilling and counter-sinking machines are in use, even in yards which do not employ electricity for other purposes. Portable hydraulic riveters are used to an extent in the frames, floors and longitudinals, at the building slip, but portable pneumatic tools, though met with in boiler shops, have been adopted to a very limited extent in foreign ship yards.

When the Author had finished reading the paper the Chair announced that the next paper on the programme would be immediately read so that the discussion could be had upon both papers together.

CAN THE AMERICAN SHIPBUILDER UNDER PRESENT CONDITIONS COMPETE WITH THE BRITISH AND GERMAN SHIPBUILDERS IN THE PRODUCTION OF THE LARGEST CLASS OF OCEAN PASSENGER AND FREIGHT STEAMSHIPS?

BY GEO. W. DICKIE.

In opening, the Author explains that this paper is written in the light of a visit to British and Continental ship yards, and on board of the S. S. *Saxonia* upon his return trip. This type of ship, he believes, represents a higher degree of skill in naval architecture than

the type in which everything is subordinated to speed. This type, indeed, will become the most important in the future extension of American shipping. The *Saxonia* carries 9,000 tons of freight at 15 1-2 knots on a coal consumption of 145 tons a day, or 1,200 tons of fuel are used to carry 9,000 tons of cargo across the Atlantic at a speed that secures a large passenger patronage. The secret of this result is, first, the great increase in size of ship, and second, fitting engines of just the size required for the speed. The old idea of having a large surplus of engine and boiler power is discarded. Present results are also had through increased efficiency of engines and boilers. In answering the question contained in the title of the paper, the Author has endeavored to make a comparison, separately, with the three factors that enter into production-skill in design, cost of labor and cost of material. In merchant work skill in design must have the commercial element as a prominent factor, and must embrace both the financial interests of the shipbuilder and the shipowner. In order to prevent these interests from injuriously affecting the interests of the shipper who furnishes the cargo, and the interests of the underwriter, who insures both shipowner and shipper, the classification societies exist. These so hedge the designer about with rules as to leave a very narrow field for the exercise of his skill. Yet narrow as this field is the progressive shipbuilders of Europe are continually pushing out the barriers, and forcing the recognition by the societies of new methods, new properties, and new combinations that have transformed not only the dimensions of vessels as now built, but methods of construction also. Continuing, the Author says that while stating these obstacles that confront the naval architect, he does not set them down as opposed to progress, "but as limitations to the free exercise of the skill in design that many naval architects, and especially those of America, think they possess." The first impression of the ambitious young naval architect, in regard to Lloyd's rules, for example, is that they are opposed to all progress, but later experience usually modifies this impression. The Author then bears testimony in his own experience to the skill of Lloyd's surveyors, but expresses the belief "that an American register of shipping that would be accepted by the shipowners and by underwriters the world over, would be a great help to the American shipbuilder, as it would no doubt lend itself more readily to the tendencies of American design. The British ship is the result of British experience, gained by British shipowners and sailors, embodied in British designs by the British naval architect, finally taking form in British ship yards; the result carrying with it much of the traditions and practice of the people and place where the work is done." He asks the question: "Now can we in America do better than this?" and adds tha we are likely to work out the problem on our own lines, in which a closer adaptation of material used to its place and function, in the complete design, will be found. The steel maker will help in this, for as he becomes better acquainted with the special needs of vessel construction he will be ready to undertake new sections, better adapted to the strains and stresses of ship structure and reducing built up work to a minimum. In this point we are now abreast of the British builder, and in methods of handling material ahead of most of them. In some of the ship yards of Europe, says the Author, a greater experience has been acquired in the production of the largest ocean steamships, both for passengers and freight, but we are in the way to obtain this experience which will come, as it has come to those abroad, by a steady and skillful application of what has already been done. Among the younger naval architects in Britain, especially, the Author found a belief that the United States is to be in the near future, "a rich field for the practice of their profession." As to the cost of labor. In Britain the whole steel work of a ship is done under the piece work system, the price per unit being fixed for certain shipbuilding districts by agreement between the builders and trades unions. This method simplifies estimating, as a certain known portion of the work has a certain fixed value. On this side, while piece work is very general, there is no uniformity in the methods of fixing prices. In British yards, as here also, the number of men on wages, on work supposed to be done by piece, is greater than that of the piece workers. The management aims to reduce the number of men on wages as compared to the number on piece work. On an average steel work in British yards costs from £3.17.0 to £4.0.0 a ton of material worked. This can about be equalled here, the Author declares. In fitting out, however, including carpenter and joiner work, painting and general finish, where piece work does not cut any figure, the cost is directly as the wages paid. American yards pay 50 per cent more wages to this class of men, and consequently the cost of labor that is reckoned in wages will be 50 per cent greater in the American than in the British yard. If half the labor cost for any given ship, built in a British yard, is paid in wages—the Author believes this is nearly correct—and that half costs 50 per cent less than the corresponding part in American yards, the total labor cost here will be 25 per cent greater than theirs. In American yards, however, while higher wages are paid the office staff of draftsmen, this part of the work does not cost any more than in British yards, as a like quantity of work can be done here with fewer men. Members of the managing staff are paid less on this side and devote much more time to their duties. The solution of the labor problem, says the Author, will be found not in an equalization of the rate of wages paid throughout the shipbuilding world, but by some method whereby every part of a ship will have a labor value fixed for it, and the workmen will receive as compensation the percentage that his labor represents of the total labor required for the particular piece of work. This system is now carried out successfully in prosperous machine shops in England. In Britain, marine engines and boilers cost less in proportion to hulls than here. Machinists and boiler makers receive about 50 per cent more wages on this side. In small tools our works are better equipped, but in large tools are no better off. The Author refers to the successful

competition of American stationary engine builders in British engineering centers and points to standardization as the secret of success. He instances a large English marine engine works in which engines of 10 to 3,000 horse power are built to gauge, and the parts stored for sale without having been put together in the shops. In this works, piece work, and a system of profit sharing, have been adopted. A standard gauge system would reduce the cost of engine erection by one-half, the Author believes. He computes that with present methods labor cost is 25 per cent greater on the hull and 50 per cent greater on the machinery of "an average ocean going freight and passenger steamer" in the American yard. As to cost of material, the tremendous fluctuations in the price of steel here is the most serious question met with "in trying to predict anything in regard to the future of shipbuilding in this country." In his opinion the tariff on steel plates and shapes makes it possible for the British builder to work Pittsburg steel into his ships at a less cost than British steel, and at a less cost than is charged the American builder for the same material in Pittsburg. In a yard on the east coast of Scotland, the Author saw steel being worked into a vessel that had been delivered in the yard from Pittsburg at less than £7 2s. 6d. per long ton. As the duty on steel is not a protective measure, and cannot produce revenue, the Author holds "it should not be maintained to render wild fluctuations in price possible." Engine forgings cost more here than in England—about 30 to 50 per cent—and in high grade forgings, such as for the U. S. Navy, there is no comparison. British forges charge £4 a ton extra for each 1 per cent of nickel in steel, but nickel steel is little used there in merchant work. In the item of wood, the British builder has an advantage of about 10 per cent in cost of material. In conclusion, the Author says, we are not yet in a position to compete with British or German builders, the difference being not less than 15 per cent in the finished ship against us. With continued experience and the labor question solved this difference may ultimately disappear. In the meantime legislation will be necessary to enable the American builder to compete successfully with his foreign rival.

As the Author, George W. Dickie, of the Union Iron Works, San Francisco, was not present, the paper was read by Walter M. McFarland.

DISCUSSION.

Naval Constructor W. J. Baxter said that, with regard to the skill of workmen, it had been his good fortune to spend two years in Scotch shipyards, and subsequently a number of years in American yards, on both the Atlantic and Pacific coasts, and from personal experience he could testify that the output per hour of the American mechanic exceeded that of the workmen of any other nation.

Naval Constructor John G. Tawressey, in discussing Mr. Gillmor's paper, said that he had the opportunity some years ago to examine a number of British shipyards, though he was not familiar with recent progress there. He was surprised, however to learn that the air plant was not making its way more rapidly in the British yards, particularly in view of the experience that had been had in this country, where it had been adapted to almost all kinds of work, both steel and wood work. At present he was using it, not only for boring and drilling, but even for driving nails, buffing work, and for sand papering boats when they were otherwise finished. At the last meeting he had made inquiries as to the experience of others with air in a cold climate, as to what should be done to keep the pipes from freezing. He had been told by some to heat the air, by others to cool the air, and by still others to do nothing at all. Since then he had tried all three methods and had found all three about equally successful. There was perhaps an explanation for this in his own experience, as at the Navy Yard in New Hampshire when the temperature becomes very low the air also becomes very dry. The relative humidity is of very small amount, and consequently the air taken into the compressor is dry and there is little or no trouble from moisture. The working temperature there was often, during working hours, only three or four degrees below zero, and sometimes in winter even lower than that. Ground in the yard is rocky and the air pipes are sometimes run on top in a wooden box, and in other places only a few inches under the surface. No trouble was experienced, provided that the water was blown out about twice a day. They had also tried the experiment of passing the air through a cooling coil, and also through a receiver with steam pipes inside. The only real trouble that was experienced was with the last—it froze up last winter. The question of an electric drive was of especial importance in navy yard work, as they had a great many machines suitable for various kinds of work, and these had to be ready so as to be able to do work quickly in any emergency. The conditions were that normally, in the yard, the machines were standing idle and, consequently, if an independent drive for each separate machine or group of machines was not adopted a great deal of horse power would be thrown away in turning over the shafting and the belts in the entire shops. It was a question of probably greater importance in the Navy Yard than in the ordinary manufacturing establishment, where the normal condition was that each machine would be doing its work. In the yard in order to have proper capacity for emergency work, it was necessary to have a great many more machines than the ordinary daily routine required. A shop without a belt would be an ideal one, but he had made no attempt to approach that condition, and, consequently, did not know what economy would result from such an arrangement. He thought that probably it would be overstepping the mark, but they had found that there was great economy in driving the larger machines independently, and grouping the smaller ones, so that the shafting connected with any particular group could be left idle, except when it was necessary to operate some one or all of the machines. Several years ago, when going over British yards, he had been impressed with the work of the beveling machines, and he did not know whether they had been put in operation in American yards. He hardly felt justified in putting one in for repair work, but he would very much like to have the opportunity to test

this machine if he had any new work to do. As to joggling machines, he understood that in addition to their use for plate work they were being adopted to some extent in the lake yards for angle bar work. With regard to oil furnaces for both plates and bars, he had found that in the intermittent condition of work in the Navy Yard such furnaces were very successful.

Naval Constructor W. L. Capps regretted the absence of Mr. Dickie; were he present it would undoubtedly stir up discussion on his paper. He had often wondered if anybody really knew what cost was. Many persons had given data on the subject, but unfortunately the same subject approached by different people produced entirely different results. "The actual cost of labor and material as between this country and Great Britain and Europe presents great diversities. I think, as Mr. Baxter said, that unquestionably American workmen are giving a greater output per hour than the workmen of any other country. That may be due to the greater nervous energy that Americans are supposed to have."

Mr. McFarland: "Strenuous life."

Naval Constructor Capps: "Strenuous life—I accept the amendment. The cost of material apparently cannot be controlled at all except by large interests. They control it to suit themselves. The ship builder has to take what he can get. As to illustrating the difficulty of arriving at actual cost of work, I know one case that came under my observation in which a contract was drawn so that certain work should be paid for at the rate which would be expressed by the cost of the work plus 10 per cent for profit. It seemed a very nice arrangement, the people were exceedingly reputable people, and everything was lovely, until the time came to settle for the work, when it took about six weeks to get anywhere near the cost of the work. The contractor made various statements, each one being the real cost of the work. But through pressure and a certain amount of argument, etc., these statements of actual cost diminished progressively. The upshot of the matter was a reduction of about one-half in the final settlement, and yet the same certified statement came with each one. So I concluded after that the question of dead cost, as viewed by the contractor and the other interested party, was a matter open to much discussion, and the people who knew most about it are not going to give us the facts."

W. D. Forbes said that no matter whether we adopted the electric drive, pneumatic tools, or other equipment, the other shipbuilding nations of the world would be equally able to use the same apparatus. Sometime ago he had the pleasure of showing around his works a well known foreign torpedo boat builder, who, after examining the equipment and the work and discussing prices, said: "If I get American machinery and take it over to my shop I do a little better, but I never do as well as you here; so I have made up my mind that the only thing to do is to take Americans there with American machinery." Continuing, the speaker said he believed this to be a fact. Many years ago, as a youth, he had worked on the Continent and in Scotch and English establishments, and it was his experience that the whole system abroad was so radically different to ours that no proper comparison could be made.

"I do not take any stock in the nervous temperament. What affects a man's work is the money he gets, and the more money he gets the more work he will do. If cheap labor was going to produce the manufactured articles of the world, China would become a very serious competitor. No nation need be a scarecrow to America until the wages paid to a man in the same position, doing the same work, approach ours. I have just turned my shop from the ten-hour system to the nine-hour system. I have made up my mind that the whole thing turns on a man's pay. The more you pay him the more you can get out of him, and the better work you can get out of him. I do not believe it is possible to have the United States stay behind in the cost of anything any length of time. I have not been in Europe for five or six years, but I saw methods when I was there in one shop that have been in existence and have not changed for years and years. I am doing work in my little shop at a hundred per cent less than they are doing it in London, with all the cheap labor, and material practically about the same. I do not believe that we have to look so much to what the machine tools will produce in cheapening our work. We are getting pretty near the limit. Of course, the introduction of this tool steel, which I see the Bethlehem people have brought forward, may help us in a great way. Jewel points to tools, I think, will be used for fine work, and used to great advantage. But all these things foreigners can get as well as we. I do look for a very great advance in cheapening products, especially for large engines, in the foundry. There is a place where we are not doing the work we ought to. A little while ago I was asked to give an estimate on some very large cylinder heads. I don't know where the engines were to go, but their estimate was about $400 on those cylinder heads. At an additional cost of about $60 per pattern the work was brought down to $40. That can be done in a great many cases. We are machining work too highly. We are taking too much care to get a bright finish that some chap with a wrench spoils the first time he gets a chance. I believe we must look to the foundries. There is one in the central part of New York that produces work the parts of which will drop together. You all know this little cyclometer. That is simply sent to the finisher in barrels, and the parts are simply taken out of the barrels and put together. The work is as accurate as any you can get from any ordinary milling machine. I had a pair of bevelled gears with a hole about 3-8 in. and a pin hole about 1-16 in. passing through the larger hole, and when I put them on a ground arbor they ran perfectly true. We can get the shipwork that is now being done in Europe, but we cannot get it unless we pay greater attention to the third subject mentioned here, and that is cost. I find that if a man is getting two dollars and a half from me and he knows that if his work equals that of a three-dollar man he is to get three dollars, and that I keep an accurate account of the work he does. That man is always pushing himself

to get the three dollar pay, and I get an immense amount of work done in that way, and in adopting that system I believe I have struck the keynote of getting the most out of the workmen that come under my charge."

E. Platt Stratton said that when abroad last summer he had business with three of the most prominent shipbuilders in the United Kingdom, one in Ireland, and two on the Clyde, and he had been very much surprised to find that each one of them had an expensive equipment of American machine tools. In one case he found that in a foundry a number of American molding machines were in operation. This, he believed, showed that the British yards were not very far behind in the matter of machinery.

Naval Constructor Francis T. Bowles inquired of Mr. Stratton as to why he differed from Mr. Dickie in the suggestion that "an American register of shipping that would be accepted by the shipowner and by underwriters the world over would be a great help to the American shipbuilder." He would like to know whv that would not be a good thing, and why it was not practicable; and, also, what part the American shipbuilders of to-day were prepared to take in the regulation of the classification societies.

Mr. Stratton replied that the classification society acted generally in a financial capacity as an intermediary between the shipbuilder, the shipowner, and the underwriter, and classification was controlled by the financial interests rather than by the interests of the shipbuilder or the ship designer.

Mr. Bowles: "But the classification society is essentially a technical organization. Now, the financial interests have got to hire somebody to do the work, and it seems to me that the shipbuilder, while he should not control the classification society, should supply the technical knowledge and he should be fairly represented. He should not actually control, but he should have such a representation that he could not be stifled."

Mr. Stratton: "The shipbuilder has always got an appeal. He has always got an opportunity to be heard in every instance. The shipbuilder is never sought to be throttled in any way, manner or shape, and the most recent rules, the rules which the American Bureau of Shipping adopted last year, were only adopted after they had been referred to every shipbuilder in this country and many in Europe, and their approval, without a single exception, was received. That is, where they responded to the circular they invariably commended those rules as satisfactory."

Walter M. McFarland said he would like to hear discussion upon the point made by Mr. Dickie that it cost 50 per cent more wages for about 50 per cent of the work on this side. He would like to hear from those who had figures, and who had familiarity with this matter.

Theodore Lucas called attention to the statement of Mr. Dickie that a considerable per cent of the cost of the hull and engines was included in that part of the work which was done by day's work, and this he understood also covered carpenter work, joiner work, painting, and the finer fitting. He believed that carpenter work, joiner work, and such matters, could be laid out in piece work, if the work was laid out by the foreman in such a way that the workman could intelligently bid on it. It was a question of distributing work in such a way that it could be brought down to units, so that the office could readily estimate on it first, and the workman also. Carpenter work, which included planking, ceiling in the holds, and other plain work ought to be laid out so that the price per square foot could be determined beforehand. With much of the joiner work and painting the same methods could be adopted. Certain manufacturers who used the pneumatic apparatus for painting large surfaces let out the work by the square foot. In England, he understood, a certain amount of work was given to a certain gang of men after they had made a bid on it, and all of this work was then entrusted to them. In the ships, such work as the shearing of plates or punching of plates could be readily handled by gangs in this way. Similar methods might be adopted in the machine shop, so that planing, for instance, could be let out at so much per square inch, or the work could be figured by the amount of material in weight that was removed from certain pieces of the engines. He believed that it would be found that workmen would be able to turn out more work of a satisfactory character if they could go right ahead on a large amount of work of the same character.

John C. Kafer said he had no doubt that this system would be possible if the builder had a large number of vessels of exactly the same kind to work on. As matters were now no two ships were identically the same, and he did not think it would be possible to lay out work in that way. The shipbuilder to-day makes his estimates on the amount of work to be done, from his knowledge of what such work had cost him previously, and so it would not be possible to make any great reduction unless a large amount of work of the same kind was to be handled. The question resolved itself largely into one of wages, for if work in duplicate could be done here it could also be carried out on the same lines abroad. In England the difficulty met with was generally on account of the labor organizations, which restricted the output. In Germany, however, the conditions were rather different, as he found on inspection last summer. There the American method of having one man attend to more than one machine had been adopted to an extent.

Mr. Tchernigofsky, I. R. N., said with reference to piece work that he would like to hear how the quality of work was affected by giving it out in this way. In his own experience in the Russian Navy Yard he found that the quality of piece work was not as good as that produced by day's work. They had appointed special inspectors to examine piece work, but it was frequently difficult to say whether the work should be accepted or condemned. Very often the work was not satisfactory.

John C. Kafer said that in certain parts of ship work it was very easy to have piece work properly done where circumstances were such where the workman could not do any serious amount of damage. If, however, plates were let out to be punched by

piece work and the workman happened to punch the plate in the wrong place, he would not be willing to pay for the loss of material, but would prefer the owner to take this loss.

W. D. Forbes said he had tried piece work, and while it worked very well on certain jobs, such as tapping a large number of holes of the same size, where there was little possibility of error, he found that to maintain the quality of work produced the game was not worth the candle. In certain lines of work where parts of the same type of machine had to be duplicated, piece work had been adopted, such as in the manufacture of small pumps; but when it came to extremely accurate work he believed that it became necessary to abandon piece work. It was better to employ a thoroughly competent man to look after the workmen and see that they were doing a fair amount of work, a man corresponding to the "prime cost clerk" of the old world. This individual was cordially hated by by everybody except the stockholders, because he would get after the men in such a case, for example, as when they would get out a shaft in eight hours one day and eighteen the next because there was not much work lying around the shop. He believed that if attention was given to the time cards, and the ambition of the workmen appreciated and properly remunerated, the piece work system would go out of existence.

H. F. Donaldson said he believed the national temperament had something to do with the output, for high wages had not been a solution of this matter abroad. In a conversation with one of the leading English shipbuilders last summer, he had been told that they had the greatest trouble with the men who earned the most money. Some of the men who belonged to the riveting gangs made very large wages and would work only three or four days in the week, and during those days they would make the equivalent of an ordinary week's work. Then they would lay off for the rest of the week and not appear again until the beginning of the following week, and they kept this up right along, so that the yard actually got less work from those men than it would get from men working regularly at the ordinary rate of wages paid to other workmen.

Charles H. Cramp said that they had had an experience with a lot of their men some time ago whom they found were working Saturdays and Sundays getting double time. These men would not work on Mondays and Tuesdays. They could afford to lay off for a couple of days.

Watler M. McFarland: "That shows that the men were possessed of American shrewdness. The fellows on the other side are too dull to do that."

W. I. Babcock expressed his appreciation of Mr. Dickie's paper, but said he did not agree with the Author's conclusions. He had some timidity, however, in speaking on the subject as he would have preferred to have heard from members who had experience in coast yards. His own opinion regarding costs based on actual facts were derived from experiences on the Great Lakes, and in the building of a class of ships which differed in many respects from those referred to in the paper, and to which its conclusions were meant to apply.

"As to skill in design little need be said. He would be a bold man who, in this room and before this distinguished gathering of the fraternity, would admit for a moment that America was lacking in that respect. From the days when the *Constitution* outsailed the whole British fleet down through the time when the American clipper ship was the acknowledged queen on the seas, to the present day, when the America's cup is still with us and the *Variag* holds the steaming record, the American designer has been at the head of the list, and no one doubts that he will remain there, no matter what new responsibilities may arise.

"Mr. Dickie's opinion that at the present time the British builder has an advantage of about ten per cent over us in the cost of material, I shall not attempt to dispute. He knows a great deal more about it than I do. In the long run, however, it seems absurd to suppose that this advantage can continue, and it seems to me not only can it be neglected now, but that we can safely count on the difference being the other way in the very near future. As a matter of fact, if we are able to ship steel to England there is hardly any reason to suppose that through a long term of years the shipbuilders in this country will have to pay more for the same steel when they have not got the ocean freight against them. I do not think the question of material need to worry us at all in that respect.

"There remains only the cost of the labor, and that is by far the most important of all. I must admit that I do not quite follow Mr. Dickie's figures here. He says that our total labor cost on a ship is twenty-five per cent more than the British cost, and also that the labor cost of the steel work of construction alone is about the same in both countries. With this latter statement I agree, for I arrive at the same conclusion from such information as I was able to obtain when over there three years ago. On the Lakes the labor on the steel work alone of a ship is about thirty-two per cent of the total cost of that ship, and all other labor, painting, carpenter and joiner work and outfit (excluding propelling machinery), ranges from seven per cent in a bulk freight steamer to twelve per cent in a package freight steamer, the latter meaning a boat with main deck, gangways, and hoisting machinery, and the former an ore, coal, or grain carrier. Now, if the labor cost on the steel work is the same in both countries it is impossible that an addition of some fifty per cent to the cost of the other labor—which in any ship would be considerably less than that on the steel work, though perhaps not as much so as on the Lakes—would add twenty-five per cent to the total labor. That is, the labor on the hull is the principal labor in a ship, and Mr. Dickie says himself that he thinks we can do that just as cheaply as they can on the other side—a steel hull. As I say, on the Lakes the other labor is almost from seven to twelve per cent of the total cost of the ship. Whatever you add to that is a very small proportion to add to the total labor. Mr. Dickie seems to think that the explanation of the equal costs in steel work lies in the piece work system. But his own statement is that even on work supposed to be done by piece there is more day work than piece work. How, then, does he account for equal costs, even supposing piece rates are the same, when our day wages are so much greater, fifty per cent he gives it,

though I think it is nearly seventy-five per cent? It seems to me the true explanation is that our men do much more work in a day, that they are very much steadier and lose a great deal less time, that they are not throttled and held down by the restrictions of labor unions, that the working day is better divided up, two periods instead of three, that our yards are better arranged and have better machinery and our management is better. Now, if we can overcome the handicap in wages in steel work, why can we not do the same in everything else? We can, and all we want is work enough to keep our yards occupied all the time, and a little more experience to prove it. It seems to me that the true explanation of the fast that we cannot compare with them in cost on steel work is, as Mr. Baxter says, that our men do a great deal more in a day. They are very much steadier. They lose a great deal less time. The English shipping papers have stated, a good many times in the last year or two that the average loss of time of the men in the shipyards in the north of England or Scotland is almost thirty per cent. That is, a man will lose nearly two days out of each week, and that unsteadiness, it is unnecessary to say here, is a very serious thing. It adds very greatly to the cost of the work. If you cannot depend on the men coming in and doing the work every day of the week it makes the cost of the work run up. Besides that, our men are not so much under the control of the labor unions by a great deal. Over there they are fairly throttled. No matter what an individual wants to do, he cannot do it. He is kept down by the labor unions, and the whole policy of the labor union is that if there is a certain total amount of work in a district, if they can make every man do less work individually per day, there will be more men employed, because in that case there will be more work to go around. Well, that works in that way in some respects, but the effect of it, of course, is to increase the cost of the work. Besides that, our working day is very much better divided up than theirs. The almost universal custom over there is to have two intermissions during the day. That is, the men go to work in the morning and then stop about nine o'clock for breakfast. They stop again at noon for lunch or dinner, and that makes three periods in the day. Now, of course, there is a great deal of time lost just before the shutting down of the shop or the yard, and there is time lost again when the men go to work. It will vary, it is pretty hard to put a time on it, but it probably averages fifteen minutes for each man for every intermission. That is, to get into the swing of his work again, and get to working steadily. Of course, in this country the work is done in two shifts only. I think it is very fair to say that our yards are better arranged, as a rule, than the English yards, and also that they are better managed. In Mr. Gillmore's paper there is a hint that one reason for that where he says that there is no inducement toward putting in improved appliances for handling material, because the men will not reduce the piece work rate. Of course, there is no use of a firm putting up an expensive machine, for instance, if they cannot do the work any cheaper when they have got it. In this country we have no restrictions of that kind.

"I think that all we need is work enough to keep our men steadily engaged, not having a feast and a famine, as has been the case for a great many years in the business, as we all know, and we can prove it that we can do it as cheap as it can be done abroad. In what I have said I have not included the engines. I am not at all familiar with the cost of English machinery, and I am not competent to express an opinion on it, but at the same time I do know this: There is a very large manufacturer of mining machinery in this country, probably the largest manufacturer of that class of machinery in the world. The firm have one shop in Chicago, and they have one shop in London. They build exactly the same machinery in each place from the same designs. The wages in Chicago are a great deal more than the wages in England—in the two shops. Doubtless the same difference that there is in the wages for other classes of labor, that is, in ship yard labor—it runs from fifty to seventy-five per cent more in Chicago. But they can build the same machinery in Chicago cheaper than they can turn it out in the English shop."

Alexander J. Maclean, referring to the statement in Mr. Dickie's paper that the average cost of the steel work of construction in the British yards was from £3 17s. to £4 per ton of material worked, said he took this to mean only the piece work prices. He had been looking over some figures on the cost of English ships which he had, and found that for the merchant steamer or "tramp" the average price in the north of England for a vessel up to three hundred and twenty feet in length was £3.17 per long ton of actual weight of steel worked in the vessel. The cost of labor for the other trades—and about twenty different trades came into play in finishing those ships—was very much higher than the cost of labor on the material in the hull alone. This, of course, would apply to a greater extent in vessels fitted for passenger service. Taking the figures on six vessels of the latter class, the labor and material should be an average of £5.76 per ton, and taking the entire cost of labor, the figures were £9.37 per ton. On the steel work in the hull it cost £4.62 per ton, and with all fittings included £4.46 per ton, while vessels, of course, especially of new types were very much higher. The cost of labor in the case of some cruisers of new type on the steel work alone amounted to £17 to £25 per ton. He did not hold with Mr. Dickie as to the statement about the amount of work done by draftsmen. Speaking from personal experience in British yards, he could say it cost very much less there to run a drawing room than it would here. In some British yards the chief draftsman was allowed so much to run his office force, including the cost of material used, and this sum was usually considerably less than it would be over here. As to costs of management, he could not speak authoritatively, but he believed that the cost of the managing force of an English ship yard was very much less than that of a similar ship yard in America.

Mr. Bailey spoke about yards in which both merchant and government work was turned out. In a ship yard that handled government work the men formed habits of extreme carefulness, and when these men were changed from government to merchant work they retained a large amount of this carefulness

which the government inspectors had enforced. For ships built for the merchant service and the general run of tramp steamers, such carefulness was not required, and it caused the work for the merchant ships to be very expensively carried out. He believed that in England the yards that built merchant work turned out a large amount of it, and the men were kept almost entirely upon this work, so that they knew just exactly what finish or accuracy was required.

Naval Constructor Joseph H. Linnard: "There is just one point that has struck me in this discussion. Those of the speakers that admit the fact that to-day we cannot compete with the British in building ships of any class seem to be undecided as to the reason, and point to our ability to compete in other lines of manufacturing, as being necessarily a reason why we should be able to compete in shipbuilding. I think, if we reflect on the lines of manufacture in which we have within recent years been successful in competition with foreigners, we will see that they have been such lines as we have in our own practice standardized. The manufacturers have standardized the types of land engines which have been spoken of in this connection. They have standardized electrical machinery. Their whole production tends to a standardized arrangement of their outfit, which becomes regular in process of manufacture, and can be put forth with a complete arrangement of their shops towards a definite and fixed end from the beginning, The question that arises in my mind is whether we will ever be able to build ships on that basis, whether we will ever be able to *manufacture* ships instead of *building* them, and that is a question that I have not heard any of those members who are engaged in commercial pursuits touch upon. I would like to hear something from that point of view."

The Chairman: "I would like to say that that is a very original idea of yours. The difference between manufacturing and building ships has always appealed to me."

E. Platt Stratton said that in English yards he had noticed that, frequently, in the case of tramps, three or four vessels would be laid down at the same time, so that the molds and the machinery outfit would be alike for all the ships. Here it was the rule to build a single ship, and where there was government work in hand the men shifted about a good deal from one style of work to another. He understood that English builders figured that where three or four vessels of the kind were built at one time the cost would be about 15 per cent less.

Col. Edwin A. Stevens said that it seemed to him the question was not so much as to the present cost of ships built here, but as to the probability of the American shipbuilders being able to compete with the English shipbuilders in the future. It seemed to him that the question was one of demand and supply. He had great faith in the American mechanic and greater faith in the American engineer, and he had invariably found that where the latter had a fair show he was pretty apt to come out near the head. He did not think it would be possible to standardize ships, but the work could be specialized. The American ship yard to-day, in order to make money, had to take everything that came along; tug boats and torpedo boats, and, perhaps, battleships were built in the same yard at the same time, and even repair work might be going on. He believed that better results would be had by carrying on such work in separate establishments, or at any rate, by creating separate departments in the same yard, and not having the work mixed together. The way to attain this end would be to create such a demand for the product as would justify shipbuilders in specializing. It was in this way, and this way only, that American bridge builders, tool builders and makers of various other classes of machinery had been able to compete successfully, not only with England, but with every other foreign nation.

W. I. Babcock, referring to the figures which Mr. Maclean had given, said he had figured out the costs per pound, which was the way they were figured on the Lakes, and he found that this gave a result of a little over eight-tenths of a cent per pound for the English tramp steamer. He could say that on the Lakes this figure had been beaten, but he believed that such figures were not valuable as a basis of comparison unless it were known how the costs were made up—what was included and what left out. The same would apply to the figures given by Mr. Dickie, as there was nothing to indicate how the cost was made up.

Lewis Nixon: "Many people say, in view of the fact that we are building men-of-war in this country at prices which compare very favorably with prices received abroad, that we ought to do the same thing in merchant ships. The conditions are very different. Men-of-war are appropriated for, and while sometimes the appropriation is not that which would build it, at the same time there is an appropriation, and the ship yards can be organized for the purpose of building them. When we are in such a position that we can build a million tons of merchant ships in a year, we will then have the demand which will enable us to so arrange the building of merchant ships that we can build with reasonable economy, and I have no doubt in the world that by that time we shall be able not only to meet the price of the foreigner, but to come under it. But in order to bring about that condition it is absolutely necessary that there should be a demand for ships which we have not now, and until we can get that it is absurd to talk of building merchant ships as cheaply as they can build them abroad. In one of the largest ship yards in this country there are five slips, each capable of building a *Campania;* and recently on one was a tug, on another a battleship, on another a ferry boat, on another a yacht, and on a another a revenue cutter. It is absolutely impossible to practice economies under such circumstances and build the ships so that they would compare favorably in cost with ships built abroad. However, there is some promise in the future, and if we can get down the cost of the raw material, there is not any question in the world that with the demand that seems to be coming we shall be able to meet and go under the price of the foreigner. Until we have that demand and we cannot get it without appropriate legislation, it is absolutely impossible to build mer-

chant ships here as cheaply as they can be built abroad." (Applause.)

The Chairman now announced a change in the order of the programme, and called upon Mr. Taft to read his paper.

A COMPARISON OF THE CONTRACT PRICES OF OUR NAVAL VESSELS.

BY HARRISON S. TAFT.

This paper is primarily a collection of charts and tables which are intended to show the "contract cost," "cost per ton" and "cost per ton-knot" of the vessels of the U. S. Navy, both numerically and graphically. They must be consulted with discrimination, for a variety of reasons, as the Author points out. The contract price of a vessel, especially a naval vessel, does not represent the actual cost of construction—completion. Usually in naval work the contractor builds the hull and machinery, in which, during the process of building, extensive changes are made and paid for as extras, and the guns, armor, and equipment are furnished by the government, the installation expense being taken up by the contractor. Some of the naval vessels have been completely furnished and made ready for sea b r the contractor, while in the case of others, the joinei and outfitting work have been done at a U. S. Navy Yard. Again, in many instances speed premiums have to be considered. In the tables the classification of vessels follows that adopted by the Navy Department, viz., battleships, monitors, armored cruisers, cruisers, gunboats, destroyers and torpedo boats. The four ships built at the Navy Yards and the four double turretted monitors have been omitted. "The cost of a hull proper does not increase directly as its tonnage, nor does the cost of an engine vary directly as its horse power. Since the horse power varies approximately as the cube of the speed, the cost of an engine will vary as some power of the speed between its square and its cube, which, of course, will make the total cost of a vessel vary more than directly as its speed." It might have been admissable to have employed some power of the speed in obtaining the figures entered under "cost per ton, knot," says the Author, but all the variable quantities entering into the solution of the problem made this refinement impracticable; and, besides, the results are relative, not absolute. As an illustration of the effect of this variation he calls attention to the "cost per ton" of the three last battleships contracted for, which is larger than for the three preceding battleships, while the "cost per ton-knot" is less. In the charts, accompanying the paper, the curves are plotted in sets, with years and months as abscissa and dollars and cents as ordinates. The several sets show the "cost per ton" and "cost per ton-knot" for individual ships, for different ships built by the same firm, and for ships of the same class built by different firms. They also show averages, extending over stated periods of time, comparative costs of different classes of vessels, and also of different firms of contractors. An analysis of the curves shows that there has been a gradual fall in the contract price of battleships and a "nearing together" of the prices of different firms. The abnormally low figures for the *Kearsarge* and the *Kentucky* are noted; and the Author points out that in the case of the last three battleships contracted for the points of the Union Iron Works are below those of the two other contractors, even with the heavy freight rates working against the Pacific coast yard. Comparing the *Denver* class of cruisers with the *Columbia* and *Minneapolis*, it is shown that though the former are each 4,175 tons less in displacement and 4 1-2 knots less in speed, the price per ton-knot is $2.39 higher than for the older ships. The high price for steel in the fall of 1899 is held to account for this, in large part. In the gunboat class there is less uniformity of prices than in the case of the cruisers, which latter show a greater uniformity than any other class. The widest range of prices is found in the torpedo boat classes. For the "cost per ton" there is a difference of $800 per ton between the highest (*Dahlgren* and *T. A. M. Craven*) and the lowest (*Davis* and *Fox*) contracts. In this class of vessels it is noticeable that in the plotted curves the points for the destroyers are much below those for torpedo boats. In summing up, the Author says that since 1888 there has been a gradual fall in prices for all classes except protected cruisers, which class has had a steady and continual rise since the beginning of the new navy. Battleships are shown to cost less per ton-knot than any other class, but this is leaving out the item of armor and, of course, armament. The three latest battleships, *Maine*, *Wisconsin* and *Ohio*, shown without armor, $234 as the "cost per ton" and $133 as the "cost per ton-knot," and with armor $390 and $217 respectively. In conclusion, the Author regrets that the latest authorized cruisers and battleships have not been contracted for in time to include them in his interesting investigation.

DISCUSSION.

Lewis Nixon said the paper contained food for reflection, but anyone who imagined that the shipbuilding fraternity of the country would get valuable data from it, from which to make estimates, was wrong in his judgment. In the first place contract prices did not always represent contract cost or actual cost, and the figures which had been presented and which were made on gross displacement, told nothing when it came to the question of the boat upon which the builder lost money. Another point, he believed an optimistic view, was where the author spoke of launching torpedo boats with steam up, passing them through their trials in a few hours, and then turning them over to the Government.

"I have been in just such a problem as that, and to get even with the trial trip is the most serious thing I am going to have. Any one who imagines that he is going to launch with steam up, go through the trial trip in a few hours and be accepted by the government, has more faith in his powers than is justified by my experience. The question of cost is one which should be discussed here as far as you can discuss it. The best stock in trade of a ship yard is its cost book. Probably there is nothing so valuable that they have. They can throw away their plans and specifications and patterns, and everything else, and would not miss them at all in the same measure as they would their cost book, and when a man thinks that he can estimate the cost of a boat with absolutely no experience, such

as would come from a thoroughly well prepared book of costs extending over a number of years, he is absolutely mistaken and simply can not make up an estimate of costs. But this paper being addressed most directly to the naval ships, I think that we ought here to look at just that problem that we have to meet in the naval ships. I remember one of the most hopeful signs that the country had in building a navy was when the present Chief Constructor, about 1885, visited the shipyards of Euope, and with his sense of perspective not interfered with in any way came back and published a report, and one of the most striking things in that report was his commentary upon the needless and growing complication of men-of-war, and we are now putting things in men-of-war which I do not believe are needed. Now, in old times, and in fact up to within a few years ago, we were perfectly satisfied to work the valves of steering engines by flexible wire ropes. You could destroy your decks, turn over your beams, do almost anything, but as long as that rope was not parted you could work the steering valves. But along comes a man who wants to suggest something better. He gets up some beautiful scheme of electricity or water, and simply because it will work at the dock, or sometimes under trial, it is hailed as a great discovery and promptly put in every ship that we have to build. I have in mind two boats, a battleship and a cruiser, where an electrical arrangement for working the valves was put on. One of them in column of vessels at sea, during a trial, got its helm jammed over and was thrown out of the column. Had she been thrown in towards the vessels on the other side, probably the results would have been most disastrous. I am not quite sure, but I think those two boats when they reached the Navy Yard at Brooklyn had this electrical steering gear promptly taken out, and that change received the endorsement and approval of the admiral commanding. We put in the next boats a scheme to work the valves by water, and then in order to make the water gear work perfectly we added about twelve pages of specifications of electric gear to describe how the water gear worked. On one trial of one of those ships a man went down to overhaul the valves and opened something in the line of the water and the thing stuck, and then this contrivance was abandoned and we have come back to the old wire rope. Those are only points which show that some things can be given too much weight. Simply because something is suggested that will work under some circumstances, it does not mean that it ought to go into a ship. It seems to me that those remarks of the Chief Constructor should be accepted as an axiom. It is the duty not only of this Society and of the construction corps—of course, I do not want to tell them their duty —but as one who sometimes attempts to build their ships, I want to say that I think all shipbuilders are interested in doing away with complications, because complicated things generally fail to work at the time we most need them.

"As regards the limit of cost of ships, I think we have an object lesson in that, which ought to be brought very strongly before the people. We have a number of cruisers appropriated for at a certain limit of cost. I believe the ships were intended to be about 8,000 tons, which means anything you choose to put in, but that anything should mean within the limits of a reasonable cost, and leave a profit to the builder. When people come to look at this problem in all its lights they say: Has the Department men trained to design ships and men who understand something about the cost of them? For men to design ships which they deliberately know cannot be built within the limit of the appropriation, and to attempt to get ships contracted for which every one knows cannot be built for the money appropriated is almost a crime, because people having faith in the men who design these ships think they are getting out ships which are not beyond the limits of the appropriation. The present protected cruisers, instead of being protected cruisers, are really designed as armored cruisers. Undoubtedly the question of high explosives must be taken into account, but a certain amount of money was appropriated to build those ships, and no one has a right to get up ships which cannot be built for the money which is appropriated. (Applause.)

"I might add to that, if you will allow me, people tell me that is all right—these ships will go to the navy yard. It was the intention of the country to have ships built for $2,100,000 or $2,200,000. Does it follow that because we find in competition many people who must have work to keep their place going, who thoroughly understand the methods of running their ship yards—does it follow that the Government is any better off because under false pretences they can put that boat in a navy yard and pretend to get it anywhere near the competing limit at which the shipbuilding establishments of the country refused?"

Naval Constructor Francis T. Bowles: "I am sorry that Mr. Nixon felt called upon to say anything unkind about the paper. The paper serves to bring up a very interesting matter, and it traces merely what you might call the technical work up to date, as it appears to Congress. I entirely sympathize with Mr. Nixon when he advocates simplifying the vessels of the United States Navy and thereby decreasing their cost and increasing their efficiency. There is no doubt whatever that we are all ready, a trifle too ready, to take up so-called improvements, with the idea of increasing the efficiency of the vessels. There is no doubt also that every time anything is required for a battleship in the way of a machine and a certain standard is set, and if it so happens that the contractor gives us a little better, a little more efficient machine than we have asked for, we are not satisfied to ask for the same thing a second time. But we push up the specification to the highest point that has been reached, without any regard as to whether the first specification sufficed for the purposes of this machine. Now, that of course increases the cost at every step. I have the utmost sympathy for Mr. Nixon and the interests that he represents, the shipbuilders' interests, with reference to designing ships that cannot be built for the appropriation. Now, the reason for that ought to be made clear. It seems to me that pretty much everybody now-a-days designs ships; there are a great many amateurs in the business, and until the designing of ships can be located in some responsible place and by people who are trained for the purpose, this difficulty cannot be overcome."

THE CHAIRMAN: "There is a great deal to be said on that side. I am sorry that you stopped where you did."

MR. NIXON: "I just want to add one little remark. Of course, I did not mean to reflect on the value of this paper. I think it is a very valuable paper. I only wanted to get to the question of real cost and not contract price. As a thorough analysis of the contracts made out from the time we started our navy to the present time, I think this is a paper which will attract a great deal of interest and which is most valuable. I only wanted to call attention to the discrepancies with regard to the question of cost. By that I mean real cost, not contract price."

JOHN PLATT: Mr. Bowles made the explanation that this was simply taking the official government lists of the vessels, and tabulating the contract price. I think it very unfortunate that this should have been done in the case of the torpedo boats and torpedo boat destroyers. The Navy Department for some reason or other started building torpedo boat destroyers with No. 1 of the last lot, but as a matter of fact there were quite a number of torpedo boat destroyers pure and simple building before that time. Those unfortunately are placed in the table with the torpedo boats, and that with other things makes this table practically of very little value as a comparison. To begin with, the *Vesuvius* is not and never was a torpedo boat. The *Farragut* is a torpedo boat destroyer pure and simple, and so are the *Stringham, Goldsborough, Bailey* and quite a number of others. For some reason they were not called torpedo boat destroyers by the Department, and that has led to their getting into the torpedo boat table. This being the case, of necessity the prices per ton and per ton knot will vary very much in the table. The Author refers to the Bath Iron Works boats; they, of course, were torpedo boats, but 30-knot boats. Those two boats were appropriated for at the same time as the *Farragut*, and they were appropriated for as torpedo boat destroyers, and it was intended that torpedo boat destroyers should be built, and money was appropriated for destroyers. Well, the contractors were fortunate enough to get torpedo boats at, very nearly, torpedo boat destroyer prices, and in that case the figures will be found to appear very much higher than the boats. That brings up an interesting question of comparison. If a comparison of costs is made with the amount of money appropriated by the government for any specific set of boats, it will be found that the cost bears a very close relation to the amount of money that was appropriated, except in almost every case of new people coming in and building a boat for the first time—their prices will be found to be very much lower than the prices of those that have been in before.

"I intended to refer to the remarks in the paper with regard to torpedo boats and the question of their being launched with steam up and out of the hands of the builder, but Mr. Nixon referred to that. One of the first boats was four years in the hands of the contractors, and was then taken over by the Government. There are three or four destroyers at the present time that have been running trial trips for a couple of years—some of them The contractors told the Government and the Government told the contractors that they could build torpedo boats and destroyers in a year or eighteen months. Some of them have been under construction between three and four years now, and they are not finished yet. So I do not think that the contractor who gets torpedo boats and destroyers has such an easy time."

NAVAL CONSTRUCTOR W. J. BAXTER believed the paper would be more valuable if it had contained certain standards of reference, for example: British rates of wages paid to mechanics for different jobs, and also average commercial price paid for material. He expressed himself as absolutely in accord with Mr. Nixon on the matter of simplification in all that had been said and a great deal more besides.

Fourth Technical Session.

President Clement A. Griscom took the chair at 2:30 o'clock in the afternoon and called the members to order for the final session, which furnished the sensation of the Convention. He announced that the first paper to be read would be that by Mr. Lucas.

CLASSIFICATION RULES.

BY THEODORE LUCAS.

"The rules of Classification Associations are the result of gradual and empirical growth," says the Author in his prefactory remarks, "and are often not quite in accord with out modern most advanced practice, nor do they represent and consider all the principal factors of importance for the safety and seaworthiness of ships." These factors are: (1) strength of hull, (2) freeboard, (3) initial stability, (4) stability under inclination, (5) water-tight subdivision by bulkheads. In questions of joining, fitting, riveting and caulking, the Author believes, "a fairly uniform standard of high efficiency" will be found in shipyards (commercial work) the world over. Variety of opinion is most pronounced in point of design. In considering the first factor, the Author subdivides this head into, (*a*) determination of numerals, (*b*) quality of material, (*c*) distribution of material. To secure strength of hull a combination of parts is necessary, so that the whole will be capable of resisting deforming influences, like longitudinal or transverse bending stresses in still water or waves, shearing stresses, vibrations under inertia, influences of moving masses of machinery, etc., and also to have each individual part strong enough to take care of local strains, like hydrostatic pressures, concentrated loads of machinery, coal, or cargo, etc. "Of all these stresses, the most formidable ones are the longitudinal bending stresses, and modern ship design attempts to determine as accurately as possible the strains in top and bottom fiber of the structure as a whole, to make sure they do not exceed a certain predetermined figure or factor of safety." The scantlings in the transverse framing are largely in excess of stress requirements (they provide rigidity to the longitudinal members), and in these the strains prove usually much smaller than in the longitudinal ones. As to (*a*), determination of numerals, it is quite apparent that "a certain rational uniformity should exist in the strains of different classes and sizes of ships." Classification societies have attempted to realize this uniformity of strains by

designating each individual case by numerals, produced from the dimensions of the ship. The factors that enter into the numerals are: length, breadth, depth, girth, and for these numerals the corresponding scantlings of the important members of the ship are taken from standard tables. The Author then enters into a detailed discussion of the systems adopted by the English Lloyds, British Corporation, Bureau Veritas, United States Standard, and American Shipmasters (old) and the American Shipmasters (new), giving in the appendix numerical examples of the application of these methods to vessels of certain sizes. From the results of these calculations, he believes that the use of compound numerals is not desirable for the determination of scantlings, "favoring same to an even dangerous degree, and discriminating against others that may be superior in seaworthiness, free board, and handiness of manœuvering." The analysis of these methods suggested to the Author a system by which a single dimension might express the relation between size and strain, for the different types and dimensions, and he gives an example of this system worked out theoretically for longitudinal strength, the formula representing a relation between the square of the length and a product of strain per unit and thickness of member. After having developed the idea the Author found that the British Corporation had in force a system of classification based on a single dimension. This classification, however, slightly varies the scantlings for each size, and he believes that simpler rules could be established by considering one dimension only, particularly as in American practice—sound and coastwise steamers—there are met vessels with a small depth compared with English conditions. From the shipbuilder's point of view a reduction in the number of different sizes of shapes is desirable. "The rules of the American Shipmasters' Association," says the Author, "have been changed with the advent of this year, and adopted without reserve, the system of numerals of English Lloyds. It seems very regretable that the Association should have copied, in such subservient fashion, antiquated English rules of doubtful scientific value, that may, even in England, finally be superseded by better methods, and against which an almost endless chain of protests has been made during the last thirty years by the most eminent shipbuilders and scientific men. The strength of Lloyds is largely in commercial and financial factors, aided by the tact of a body of able officials who are competent and willing to compromise on the most glaring defects of their rules. But it is a small compliment to American engineering judgment to see such a feeble copy of an antiquated foreign system offered as a help for the healthy development of an American merchant marine just at the critical moment of a new awakening of the maritime interests." As to (*b*), quality of material, the Author states the same feeling can be had against the specifications of the quality of steel. "The American Shipmasters' Association specified in 1893 20 per cent elongation for all sizes of plates, to the apparent satisfaction of shipbuilders, ship owners, and insurance men. In imitation of Lloyds Rules and Bureau Veritas, this elongation has been reduced in the 1900 rules to 16 per cent for plates under 18 pounds, while Lloyds place this 16 per cent limit under 8-20 in. and Bureau Veritas at 1-4 in. plates and under." The Author sees no reason for this cutting down of specifications, and terms the European requirements "antiquated" and sure to change. Again he says the American Shipmasters' Association exercises no direct inspection of the quality of material, requiring only the manufacturer's guarantee. "Such lax methods of inspection ought to make it easy for steel makers to sell the poorest stuff as good enough for ships." He also criticizes the absence of any chemical requirements (limits of phosphorus, and possibly of sulphur and silicon) and failure to state contraction of area. The average hull steel is of low quality, and the Author knows cases where hull steel would not stand flanging to 90 degrees over a large radius. Attention is called to the report of the American Section of the International Association for Testing Materials, as to ships, which is appended to the paper, and also to the fact that Lake shipbuilders use specifications which call for a soft steel of 24 to 25 per cent elongation, and which cover contraction of area and the phosphorous limit. As to (*c*), distribution of material, there is much room for improvement. If merchant practice would follow naval practice to some extent, and lighten the lower part of the ship a little, and increase the stringers, sheer strakes, and deck plates in thickness, a much stronger and more efficient ship would be the result. The use of inner bottom tanks might be discouraged, and deep tanks, wing tanks, or similar arrangements substituted. These would also be more desirable for stability's sake. For correcting mistakes of design in trim or stability pig iron and not water ballast should be used. As to factor (2), freeboard, the American classification rules fix freeboard as a factor of depth of hold. This is insufficient, "as the length of the ship is of considerable influence upon the possibility of waves proving dangerous to the ship." Factor (3), stability, is utterly ignored by the classification regulations. The grossest outrages in this respect may be committed by shipbuilders without any protest from either owner, surveyor or underwriter, while a slight reduction or rearrangement of scantlings is punished by a change in the insurance rates. Supervision ought to be exercised in the direction of securing sufficient breadth in relation to depth for determination of metacenter and center of gravity. The difference between these is the metacentric height—the measure of the initial stability—and this the Author places at 1.00 to 3.50 feet as desirable values for merchant ships. Factor (4), stability under inclination, is generally satisfactory—with sufficient initial stability and the type of huricane deck ship frequently employed in American practice. Factor (5), water tight subdivisions by bulkheads, is discussed at some length by the Author. "The classification rules treat this important subject very indifferently and ineffectively." He instances the steamships *Elbe*, *La Bourgogne*, the ferryboat *Chicago* and the steam yacht *Alva* as cases in which calamities would have been "reduced to accidents of small importance" had proper hull subdivisions existed. In practice ships are often passed by classification societies in which the tops of bulkheads extend only slightly above the load line. Classification regulations might, with advantage, follow

oil-tank practice and specify bulkhead stiffening that could stand for days the pressure of a filled compartment in a sea-way. Accompanying the paper are typical mid-sections designed under both Lloyds and Bureau Veritas rules.

DISCUSSION.

E. Platt Stratton, Surveyor of the American Bureau of Shipping, formerly the Shipmasters' Association, read a statement in which he characterized the paper read by Mr. Lucas as a "tissue of pretense," and charged the Author with an effort to "advertise himself" and with "wilful misstatement." He said the American Bureau had not sought to hide the fact that it had copied Lloyds Rules "with variations," having published an announcement to this effect in its "Record." As to the inspection of steel, the speaker quoted from the "Record" a rule that the tests of material prescribed by the Bureau were to be made at the place of origin, under the personal inspection of an inspector who was not connected in any way with the steel mills. He also charged that Mr. Lucas was "spokesman" for the British Corporation, and referred to the S. S. *Verona*, built under the rules of that corporation, on which the sum of $40,000 had been expended in hull repairs after her first ocean voyage. Certain banking interests had recently asked the American Bureau to examine plans for two 11,000-tons ships designed to conform to British Corporation rules, and the American Bureau had rejected these vessels as "light and unserviceable." The plans had subsequently been changed and were now awaiting approval at the Bureau.

Mr. Lucas, after receiving permission to reply first, said that he would make no answer to the personalities contained in the paper read by Mr. Stratton, but would confine himself to the subject of classification rules from the point of view of the naval architect. He was interested solely to aid in the effort to bring the American merchant marine to the highest standard possible, for the best things only were good enough for America and for American ships. The official list published by the American Bureau of Shipping did not contain the name of any inspector who was permanently stationed at steel mills in the employment of the Bureau. As to the report sent to Mr. Stratton, the speaker understood that it was sent by a firm of inspectors employed by the steel mills, and anybody could see that those men were comparatively easily influenced by the interests of the steel mills rather than by the interests of the classification society. The case cited of the steamship *Verona*, as classified by the British Corporation, had really nothing to do with the strength of ships. It was simply a case of insufficient ballasting and of sending the ship out to sea in rough weather. There have been many cases of vessels built under different classification rules being sent to sea with insufficient ballast, and many such vessels had arrived with rivets started and in a condition demanding a large amount of repair work. Within the last few weeks the speaker had found out that the British Corporation was not the only classification society that employed single dimension rules, but that a similar rule is employed by the Great Lakes Register. In this they start with the length only and subdivide according to beam and depth slightly, but the main classification is by one single dimension, that of length only. He said that he had simply submitted his standard to the Society for discussion, and would be glad if the Society would create a standard instead of that he proposed.

Charles H. Cramp said that he believed Mr. Lucas was mistaken in his reference to the classifying and arranging of structural strengths of British vessels according to Lloyds Register. He quoted the statement in Mr. Lucas' paper that the American Bureau of Shipping had adopted the system of Lloyds numerals, against which system protests had been made by eminent British shipbuilders. The speaker said that he knew that the rules which had been adopted by the British Lloyds had been established by yearly meetings of the most distinguished British shipbuilders. The Lloyds association invited certain gentlemen who were not manufacturers of ships, but who were trained shipbuilders, to meet and modify the old plans and adopt new ones, with a view to classifying their ships. No matter what kind of classification rules were gotten up, there would be always some protest against them. He had experienced no trouble with either Lloyds or the American Bureau of Shipping. As a rule, his firm made a midship section and sent this, together with a general description of the vessel, to the Society, and he did not know of a case where the section or the plans for construction had been rejected or modified. If they had any trouble at all, it was with the inspection officers of the U. S. Treasury Department. The last three ships his firm had built were constructed under Lloyds regulations, and also under those of the American Bureau of Shipping. The first vessel completed was loaded with 5,000 tons of coal and was ready for sea, when the local inspector of the United States Government condemned the bulkheads. These bulkheads had been built according to Lloyds requirements and the rules of the American Bureau of Shipping, which had adopted Lloyds bulkhead requirements. The local United States inspector, however, refused to report that the vessel was constructed in accordance with the Government plans.

Secretary Francis T. Bowles said that he was satisfied that Mr. Lucas had written the paper in what he considered the best interests of the naval architect, and he believed it should be received in the same manner. He suggested the liberal application of the blue pencil to the written discussion submitted by Mr. Stratton.

E. Platt Stratton moved that "in view of the mistakes and untruthfulness of the paper under consideration, both it and the remarks bearing upon it be excluded from publication in the Proceedings of the Society."

President Clement A. Griscom inquired if the motion was seconded, but his inquiry met with no response.

Charles H. Cramp agreed with Mr. Bowles in the belief that Mr. Lucas had been sincere in his presentation of the matter, but that he had been mistaken in some particulars. The speaker did not believe that it would be possible to write a lengthy paper on the

subject without making mistakes. Referring to the suggestion of Mr. Lucas that merchant practice should follow naval practice to some extent, and lighten the power part of the ship while increasing the thickness of the members in the upper part, he said that most merchant ships are a little thicker on the bottom than naval vessels, but that was caused from so much wear and tear on that portion of the ship. This would be apparent to anyone who would go under a ship's bottom in dry dock.

E. Platt Stratton said that previous to his connection with the classification society he had regarded this organization as an obstruction to shipbuilders and shipowners, but he had hoped and believed that there was a medium ground on which this society could facilitate the work of the owners and builders, and in his work in that field he had endeavored to fulfill that requirement. He did not take the position that the classification society was an institution not to be criticised. Healthy criticism was necessary in order to make it what it should be, and he believed it would be a step in the right direction for the Society to take such action as it might see fit in this matter.

Sinclair Stuart said that as surveyor of the British Corporation he would like to call attention to the statement made by Mr. Stratton about two steamers under construction at Sparrow's Point, and he asked him what information he had about these steamers as to their construction, material, displacement, stability, etc.

E. Platt Stratton explained that plans of the steamers had been brought to his office, and the Bureau had reported to the owners that they would not classify the vessels, and subsequently plans of two other vessels were brought to the office from Sparrow's Point, and these he assumed to be plans of the same ships.

Sinclair Stuart said that they were not plans of the same vessels, and that the steamers which were under construction at Sparrow's Point, to be classified by the British Corporation, were so constructed that they would be insured at the lowest rate. He entered a protest against statements tending to disparage competitors or the ideas of the members about shipbuilding.

Naval Constructor W. L. Capps moved an amendment to Mr. Stratton's motion, that the Author of the paper and those who had taken part in the discussion be permitted to eliminate personal remarks, as such did not contribute to the information of the Society, or the dignity of the Proceedings.

Mr. Stratton accepted the amendment, which was put by the Chair, and in this form was passed unanimously by the meeting.

Joseph R. Oldham, in a communication, referred to Mr. Lucas's expressed preference for the system adopted by the British Corporation, in which the classification was based on a single dimension—length.

"As regards this it seems to me that using the length only would be too simple. As an example of this consider two vessels such as the S. S. *Germanic*—446x44x32—and the *Morse*—450x50x28. These hulls are almost of the same length, but are quite diverse in their other proportions. If length only were adopted to govern the thickness and strength of plating, the two hulls would be about alike. But, as a fact, the plating of the *Morse*, which is of steel, is thicker than the iron plating on the *Germanic*, and, I think, correctly so. Many other examples giving similar results might be added to show that the length only would not be suitable for regulating the scantlings. In the Great Lakes Register of Shipping I adopted displacement, regulated by the number of depths to length as a basis by which to fixe the scantlings, the dimensions of material being expressed in decimals. But what I consider better than all would be to attach to each augmentation of length the moment of inertia above and below the neutral plane, with a minimum thickness for each length. This would be simple enough and it would leave shipbuilders free to exercise their own judgment to a considerable degree without undue risk. As to the loading of vessels, I may say that the underwriters have often tried to regulate that, and sometimes with success. In the case of Alfred Holt's steamers, for instance, they were worked according to a load line approved by the Liverpool underwriters, but in those days the majority of owners preferred to load their vessels according to their own theories or practice, and the results were bad. It would, however, be difficult and somewhat hazardous for underwriters to define a load line, for such would not be of much use unless they possessed powers to detain, and that authority would be useless unless they kept a large staff to ascertain when vessels were overloaded; and altogether the matter has been found to be too complicated for any syndicate of underwriters to govern. The principal danger in overloading is not that of augmentation of bending moment—for the energy with which a vessel in her light condition rises and falls on the waves is sometimes greater than when she is loaded—as the diminution of bouyancy may reduce the stress on a floating hull in a seaway. What is most to be feared is foundering through the deck openings becoming exposed and a lessening of the range of stability, due to a reduction of the freeboard. An upper bottom appears to me to be about the most important adjunct of safety in vessels possessing stability of form, and this should be a *sine qua non* in the design of merchant ships. And if there be a double bottom, the easiest way of ballasting a ship is to fill that space with water."

President Clement A. Griscom now announced the reading of the paper on the new ships for the Navy.

RECENT DESIGNS OF BATTLESHIPS AND CRUISERS FOR THE UNITED STATES NAVY.

BY CHIEF CONSTRUCTOR PHILIP HICHBORN, U. S. N.

In opening, the Author states that the designs as they appear in the paper are incomplete, but in response to the popular and professional interest in the subject they are presented in the condition at the time of writing, together with authoritative data as to equipment, armor, armament, etc. Warship design, the Author

reiterates, is a "compromise," but he believes, nevertheless, that the designs presented, which are the result of much thought and serious consideration, will be found "superior to all previous designs of similar character produced in this or any other country." The programme, for which the designs presented in the papei have been made, includes the construction of five battleships, six armored cruisers, and three protected cruisers. The dimensions of the proposed battleships are: length on load line, 435 ft.; length over all, 441 ft., 4 in.; beam moulded, 76 ft.; draft, mean, 24 ft.; displacement, 15,000 tons. "The most noteworthy departures from previous designs are increased length, which has been necessitated by the increased speed and coal endurance demanded by many advanced strategists, inclined armor at the forward end of the redoubt, an arrangement of the casemate armor which permits the broadside battery to be snugly housed without dismounting, and the substitution of water-tube for the conventional Scotch boilers." The armament is "unquestionably the heaviest battery afloat," the arrangement being to give a powerful bow, stern, and broadside fire, and for the 12-in. and 8-in. guns the American system of mounting in turrets has been adhered to. The batteries for these ships include: Four 12-in. and eight 8-in. B. L. rifles, twelve 6-in. rapid firers, twelve 14-pdrs., twelve 3-pdrs., four 1-pdrs., and eight automatic and field guns. They will each have two submerged torpedo tubes. Armor protection will include a complete water line belt, about 8 ft. wide, ranging in thickness from 11 in. to 4 in. according to position. There is also 6-in. casemate side armor continued at the inboard ends to form a central redoubt for the 6 in. guns. Turret armor for the 12-in. guns will be 10 in. thick, and for the 8-in. guns 6 in., and the barbettes will be of the same thickness. Splinter bulkheads and gun shields will be used also. In four of the ships, four of the 8-in. guns will be mounted in the upper portions of the superimposed turrets, and the remaining four 8-in. guns will be placed in pairs in balanced turrets, on each beam. In the remaining two battleships the eight 8-in. guns will be placed in four separate balanced turrets, one on each beam near the forward end of the superstructure, and one on each beam near the after end of the superstructure. The 6-in. guns will be mounted broadside on the gun deck. The propelling machinery of the battleships will consist of twin screw, four cylinder, triple expansion engines of 19,000 collective horse power. Water tube boilers of the straight tube type, built for a working pressure of 250 pounds, will be installed. On each ship an extensive electric plant will be placed. The six armored cruisers will be very powerful vessels, of these dimensions: length, 502 ft.; beam, 69 ft. 6 in.; draft, 24 ft. 6 in.; displacement, 13,400 tons. Coal bunker capacity, 2,000 tons. As designed three of these vessels are sheathed and coppered, and three unsheathed. Estimated speed is 22 knots, and a large radius of action is possible. These vessels will be protected by an armor belt at the water line, 7 ft. 6 in. deep, running from stem to stern. Side and transverse armor will be joined so as to provide a central casement, and there will be two turrets, one forward and one aft, 6 in. thick, the barbettes being of the same thickness. There will also be splinter bulkheads, and a protective deck ranging in thickness from 4 in. to 1 1-2 in. The armament of these vessels will include: Eight 8-in. breech loading rifles, fourteen 6-in. rapid firers, eighteen 14-pdrs., twelve 3-pdrs., four 1-pdrs, all rapid fire; also four 1-pdrs., automatic, and other rifle caliber and field guns. They will each have two submerged torpedo tubes. The main engines for driving the twin screws will be of the four cylinder, triple expansion, type, of 23,000 collective horse power. The cylinders will be 38 1-2 in., 63 1-2 in., and (two) 74 in dia. by 48 in stroke. Each ship will be fitted with thirty boilers of the straight water tube type in eight separate water tight compartments. There will be seven separate electric generating units of a total rated output of 6,250 amperes at 80 volts. Designs for the protected cruisers show vessels of these dimensions: Length, 424 ft.; beam, 66 ft.; draft 23 ft. 6 in.; bunker capacity, 1,500 tons, and trial displacement 9,700 tons. These vessels will have a partial water line armor belt about 200 ft. in length, abreast the boiler and engine spaces, the belt being 7 ft. 6 in. wide and 4 in. thick. Above this for about 133 ft. of the length the sides will be protected by vertical armor, about 7 ft. in width and 4 in. in thickness, connecting at the ends with 3-in. transverse armor. The other protection will be provided for by sponsons, splinter bulkheads, gun shields, and a protective deck—according to the respective positions. The armament will include fourteen 6-in. rapid firers of 50 calibers length, eighteen 14-pdrs. R. F., twelve 3-pdrs., semi-automatic, four 1-pdrs., automatic, and eight 1-pdrs. R. F., and there will be the usual rifle caliber and landing guns. These vessels will be fitted with powerful machinery, to attain a trial speed of 22 knots. The engines driving the twin screws will be of the four cylinder triple expansion type, of 21,000 collective horse power with 250 pounds steam pressure and about 133 revolutions. Each engine will be in a separate water tight compartment, as will also be each group of four water tube boilers. There will be in all sixteen water tube boilers of the straight tube type. The electric plant will consist of five independent units of a combined capacity of 5,375 amperes at 80 volts. Names for these vessels have been decided upon as follows: Battleships, sheathed and fitted with tandem turrets, *Pennsylvania*, *New Jersey* and *Georgia*; Battleships, not sheathed and with main battery in independent turrets, *Virginia* and *Rhode Island*; Armored cruisers, sheathed, *West Virginia*, *Nebraska* and *California*; Armored cruisers, not sheathed, *Maryland*, *Colorado* and *South Dakota*; Protected cruisers not sheathed, *St. Louis*, *Milwaukee* and *Charleston*. Accompanying the paper is a magnificent collection of drawings of the proposed vessels.

DISCUSSION.

Alexander J. Maclean said that, after looking over the drawings, he was struck with the conservatism of the U. S. and foreign navies in the matter of equipment. He noticed that the old fashioned stock anchor had been retained. The German Navy had tried the stockless anchor and found it very effective, and he understood that a trial of an anchor of this sort had recently been made on a British battleship and it had proved very effective.

There was no further discussion.

ON THE LAUNCH OF A CRUISER AND A BATTLESHIP.

BY JAMES DICKIE.

The vessels referred to in the paper are a cruiser 344 ft. long, 52 ft. beam, and of 2,400 tons launching weight, and a battleship 348 ft. long, 69 ft. 3 in. beam, and of 4,100 tons launching weight. The building slips were constructed on a mud flat, the mud ranging from 70 to 85 ft. deep to hard pan. The flat was piled with Oregon pine, from 70 to 80 ft. long and 14 to 18 in. dia. at the butt. Each pile could readily support 20 tons. Capping on top was 12 in. by 12 in., joists 4 by 12 in., spaced 24 in. centers, and planking 4 in. thick. The Author had employed launching weights per foot of surface ranging from 1 1-2 to 3 1-4 tons successfully. As a lubricant, on weights from 1 to 2 tons, soft tallow; from 2 to 2 1-2 tons medium tallow; and from 2 1-2 to 3 tons hard tallow, is recommended. Over 3 tons almost pure stearine is required. Temperature has to be considered in selecting the lubricant, but on the Pacific coast no trouble is met in this respect. After long experience the Author has found tallow and soft soap the most satisfactory. As to inclination, he has used one in fourteen for small vessels, and one in twenty-four for large vessels, with ways laid concave and convex, according to circumstances. Launching curves are prepared to determine the length of ways necessary, so that the strain on the bottom will not be too great before the vessel is water borne at the after end, and also to determine the strain on the forward poppets, when the vessel lifts aft. Treating of the two launches separately, the Author says the keel of the cruiser was laid at an angle of one in twenty, with bottom of stern post 14 in. above high water. Keel blocks were spaced 5 ft. centers, with four bilge blocks and twenty-eight shores on each side—an average of 18 1-2 tons to each block and shore. Blocking under the ways was spaced 5 ft. centers for two-thirds the length of the sliding ways at the upper end. For the remaining one-third, and for about 20 ft. aft of the after end of the sliding ways, the blocking was spaced 2 1-2 ft. centers, and from thence to the lower end about 5 ft. centers. Oregon pine without heart was used for groundways and sliding ways; the former 10 in thick by 18 in. wide by 60 ft. long, and the latter 8 by 18 in. and the lower piece 10 in. by 18 in. The sliding ways were in 5 pieces. Groundways were laid straight at an angle of one in eighteen, as far as the piling extended —28 ft. aft of the heel of the storm post. From that point, 73 ft. farther out, the mud was planked over with plank 24 ft. long by 6 in. thick, laid crosswise. The ways were laid level transversely, and no side shores were used except to correct any side curvature of the timber. Cross ties 4 by 6 in. were fastened under the ways 30 ft. apart, to insure them remaining the proper width until the vessel came on them. In launching over mud, the vessel carries a wave of mud ahead of her, and it is better to fasten the ways directly to the planking, so that they will be the proper width when down to their proper level. If side shores are used and the ways rise up, the shores have a tendency to pull the ways out and the vessel drops between. No shoring inside the vessel was used. All packing and wedges were fitted, using a small block the thickness of the sliding way, so that they were greased before being put in place. The lubricant was tallow stearine, heated and laid on in an even coat scant 1-16 in. thick. Over this there was a layer of oil soap. The Author then describes the final preparations for launching in detail—sliding ways and dog shores. The launching weight of the cruiser was 2,400 tons, and of the moving part of the cradle about 34 tons, a total of 2,434 tons. The ways had an effective bearing surface of 17 3-8 in. by 274 ft. in length, making 793 1-2 sq. ft. ÷ 2,434 = 3.064 tons per sq. ft. The cost of labor and material for the launch was: Labor, $1,182.20 and material, $436.10, a total of $1,618.30, which equals 66 28-100 cents per ton weight. Lumber charged to the launch included only that bought for it; stock on hand that had been used before was not charged. On the day of the launch there were employed thirty carpenters, eight boys, ten laborers, eight riggers, the superintendent of the yard and the yard foreman. The time occupied was reckoned from "started to ram up" at 9.58 A. M., to "finish and let go" at 11.24 1-2 A. M., = 76 1-2 minutes actual working time and 52 minutes resting time. Describing the launch of the battleship, the Author says the keel was laid at an angle of one in twenty with the heel of the stern post touching the water at high tide. As the mud outside of the yard was too high to admit of planking on top of it, piles were used to the extreme end, and to reduce the cost the ways were laid on a curve. Eight inches rise of arc in 264 ft. was the curvature decided upon. This gave a mean inclination of ways in the length of the cradle, before the vessel started to move off, of one in twenty-one and a half, and at the extreme lower end, 88 ft. from the heel, an inclination of one in fourteen. Details of the keel blocks, launching ways, shores, etc., follow. The launching weight of the vessel was 4,100 tons and of the moving cradle 62 tons, a total of 4,162 tons. The total beaming surface was 1,621 sq. ft. or 2.57 tons per sq. ft. Costs of launching included: Labor, $3,541.70; material, $1,253.80, a total of $4,795.50, or $1.15 per ton weight. The launch from start to finish occupied 155 minutes, made up of 118 minutes actual working time and 37 minutes resting time. Accompanying the paper is a table of data of the launches described, also several diagrams, showing the plan of piling, launching curves for each ship, arrangement of timbers, guillotine, and photographs of the forward and after poppets.

DISCUSSION.

HERBERT C. SADLER, in a paper submitted to the Secretary, said: "The launch of a large vessel is one of the most serious engineering problems that a shipbuilder has to contend with, and it is only natural that the practice should vary in different places. Referring to the pressure per sq. ft. of ways, Mr. Dickie says that he has successfully launched vessels where this amounts to as much as 3 1-4 tons. This figure seems to be rather on the high side, especially for large vessels. It may be of interest to note that on the Clyde the greatest pressure allowed seldom exceeds 2.6 tons per sq. ft., and in general varies from 1.8 tons to 2.5 tons, the latter figure being the usual one for large merchant vessels and warships.

Even with this amount of surface, there is usually a considerable amount of smoke towards the end of the launch. The camber, which is in all cases convex towards the vessel, varies in large vessels according to the weight, from 9 to 20 in., 12 in. being a common amount. In a number of ship yards, especially those on the upper reaches of the river, every vessel has to be checked by suitable drag weights in order to prevent her running into the opposite bank. These are usually arranged so that the whole amount does not come into play at once. There is, of course, a considerable variation in the amount of this weight, depending upon the length of ship and breadth of river, but in general this varies from 3 per cent to 5 per cent of the launching weight. The declivity, which varies with the size of ship, is usually from one to twenty-four at the fore end, to one in sixteen, to one in fourteen at the after end, the mean declivity in the case of large merchant vessels and warships being about one in twenty to one in twenty-five. Without doubt, as Mr. Dickie says, tallow and soft soap form the best lubricant for launching ways, and in cases where other substances have been used the results have sometimes been disastrous. The saddles shown at the after end of the vessels are not usually necessary, as in the case of twin screw vessels sufficient support for the after poppets may be obtained from the bossing, and in any case this part of the structure is not subjected to the same stresses as the forward end."

THE SAFETY OF TORPEDO BOATS AT SEA AND IN ACTION UNDER VARIOUS CONDITIONS.

BY NAVAL CONSTRUCTOR LLOYD BANKSON, U. S. N.

This is a short academic paper written by the Author to accompany a series of charts and tables, which refer especially to the U. S. torpedo boats *Ericsson* (built) *Bagley*, *Barney* and *Biddle* (building). He endeavors to point out what may be expected to occur to these boats when they are seriously injured or in danger in bad weather, and what chances they may have of keeping afloat. Referring to the graphical presentation of the subject, the Author points out that the center of gravity of each torpedo boat is fixed, and the vessel seeks the water line which will bring the center of buoyancy vertically below the center of gravity for each supposed bilged condition. The data for the calculations presented by the Author were obtained from the Bonjean curves for each torpedo boat. These curves are simply a series of displacement curves for short sections of a vessel from stem to stern, each section being bounded by transverse planes at the forward and after ends, so that by drawing any water line for the vessel out of the regular longitudinal trim, the sum of the various displacements from the Bonjean curves will give the total displacement for any longitudinal difference in trim. In passing, the Author remarks that the Bonjean curves are essentially French, and he expresses surprise that so little attention is paid to the scientific methods of analysis employed by French constructors. From the plotted results, the Author draws the conclusion that the chances of total loss of a torpedo boat are not so desperate as one might be led to expect. Various emergency devices in the fire and engine rooms have, he believes, diminished the chances for fatalities there, and another source of safety to the boat, when hunting in couples or groups, is that the disabled boat can be toward quickly out of action, either bow or stern first, and by the use of ejectors and pumps be sufficiently freed of water to make leak stopping possible. In regard to the seaworthiness of boats, they usually have a large range of statical stability. The angle of vanishing stability varies from about 70 deg., in some boats, up to and beyond 90 deg., in the case of the *Ericsson*. The Author considers the shallow draft of some of our torpedo boats as carried to an extreme, and suggests that a deeper design be adopted so as to increase their stability and seaworthiness. As to the above water portion of the boat, the Author admits that in a rough sea there is little hope for a boat in which the deck or shear strakes, or both, are seriously cut up or injured, amidship, by shell fire. Another source of danger is driving these light constructions at full speed into a head sea. The result may be that bows will be stove in, bent or twisted, as has happened in practice. In the diagrams illustrating the effect of bilged compartments of the U. S. S. *Bagley*, etc., the draft at the normal loaded conditions is shown to be 4 ft. 6 in. forward and 8 ft. 8 1-2 in. aft. With the after engine and boiler rooms flooded and open to the sea, the change of trim gives a draft of 5 ft. 5 in. forward and 11 ft. 2 1-2 in. aft, but at no point is the deck below water. The boats are shown in various other positions, with forward, midship, and after compartments flooded; in some extreme cases the boats being partly submerged though still afloat.

This paper was read by title and there was no discussion. The meeting then adjourned.

Social Features.

On Friday night, November 16, the annual banquet of the Society was held at Delmonico's, with President Clement A. Griscom as toastmaster. There were about 150 members and guests present, and among those who responded to toasts were: Congressman Amos Cummings, Col. A. L. Snowden, Col. J. J. McCook, Lewis Nixon, Stevenson Taylor, Wm. McFarland and Ex-Engineer-in-Chief C. H. Loring, U. S. N.

On the day following those who had accepted the invitation to visit Cramps' Shipyard took a special train at Jersey City and were taken right through to the yard without change, the train being switched through the streets of Philadelphia for the convenience of those on board. The objective point of most of the visitors was the Cruiser *Variag*, which lay alongside the fitting out wharf. The entire vessel was open for inspection, and the guests were accorded a cordial welcome by the Russian naval officers who have overlooked the construction. The engines, of the torpedo boat type, and the American built Niclausse water tube boilers were of special interest, and the extensive electric generating plant and the Russian naval ordnance were thoroughly scrutinized and occasioned favorable comment. A special feature of the equipment was the metallic furniture with

which all the living quarters were furnished. In the afternoon the guests were entertained at luncheon in the mould loft by the builders. A pleasing incident of this was the splendid reception given by the gathering to the veteran engineer, Charles H. Haswell, who arrived after the others were seated. Later those who were returning to New York re-entered the special train in the yard and carried away very pleasant remembrances of this social feature of the eighth annual meeting.

Chief Constructor U. S. N.—Upon the retirement of Rear Admiral Philip Hichborn on March 4 next the position of Chief of the Bureau of Construction and Repair at Washington will be filled by Chief Constructor Francis T. Bowles, who is now in charge of the work at the New York Navy Yard. As Mr. Bowles was born at Springfield, Mass., in 1858, he will have reached the highest place in the engineering branch of the service at the age of forty-two. Mr. Bowles entered the Naval Academy at Annapolis in 1875, and was graduated as a cadet engineer with the highest honors. He was selected for a supplementary course in naval architecture abroad, and was appointed and assumed the duties of Assistant Naval Constructor in November, 1881. Mr. Bowles' professional attainments are of the highest order, and his great executive ability has been demonstrated in the management of the Portsmouth, (Va.) Navy Yard, and, later, at the Brooklyn (N. Y.) Navy Yard. Mr. Bowles is known professionally to a very large circle of engineers as secretary of the Society of Naval Architects and Marine Engineers.

Pollak Prize.—In competition for the prize offered by the heirs of Mr. and Mrs. Anthony Pollak, of Washington, D. C., who were lost on the S.S. *La Bourgogne*, a number of models were exhibited at the recent Paris Exposition. The prize, $20,000, was sufficiently large to interest inventors in many different countries, and there were in all about 400 competitors. The committee of award included prominent naval officers and persons engaged in maritime affairs of various countries, and its members decided that none of the plans submitted warranted the award of the entire sum. A prize of $2,000 in cash and a gold medal was, however, awarded to Leopold Roper, a British naval architect. He exhibited two separate systems: one a new form of davit and steel lifeboat of a type recently installed on the Cunarder *Campania*, and the other a life raft of large capacity, which in times of safety is used as the navigating bridge of the ship. It has been decided to hold another competition some time in the coming year.

The tests of the new 12-in. naval gun carried out at Indian Head, last month, showed that the weapon is superior to any other gun of the same calibre yet constructed. With a charge of 360 lb. of smokeless powder, a muzzle velocity of 2,854 ft. a second was recorded.

Control of the yard of the Union Dry Dock Co., at Buffalo, N. Y., has been secured by the American Shipbuilding Co., which now operates all the lake yards, except the Craig plant, at Toledo, O., and the Jenks shipyard at Port Huron, Mich.

SMASHUP OF THE STARBOARD ENGINES OF THE AMERICAN LINER ST. PAUL.

When the American liner *St. Paul* finished her last westward trip at New York, on November 4, she reported a serious mishap which had occurred in mid-ocean. Five days previously, at about 8 o'clock on the night of October 31, the vessel lost her starboard propeller and about 10 ft. of the tail shaft, and this was followed by a smash up in the starboard engine room, which, fortunately, did not cost any loss of life or jeopardize the safety of the vessel or those on board. The port propeller and engines were intact, and the vessel continued steaming westward at reduced speed. So slight were the manifestations of this mishap, and so perfect was the discipline of the crew, that few, if any, of the passenger realized at the time that anything unexpected had occurred.

The vessel had left Southampton October 27 with a full cargo and 316 cabin and 245 steerage passengers. Nothing whatever had occurred in either the engine or deck departments prior to the accident that would have given warning of possible disaster. At the time it occurred the position of the *St. Paul* was latitude 46.13 north, longitude 48.03 west—about half way across. There was a heavy sea running, and the vessel was moving about pretty lively, though making good time.

Just what occurred outboard and inboard is at this time, when the survey and adjustment are incomplete, largely a matter of conjecture. One theory is that the vessel struck a derelict in such a position that the starboard engine was brought up all standing, and the inertia forces coming into play caused a failure in the engine and shafting at the weakest points. The other and most generally credited theory is that the starboard propeller coming out of the water started the engines to racing, that a hidden flaw caused a fracture of the tail shaft and the engine, relieved of all load, ran away, the speed governor failing to act. Whatever may have been the cause, the result was that the forward end of the crank shaft lifted, stretching the main bearing bolts and cracking the engine seatings. The stretching of the bolts being greater than the cylinder clearances on top, the result was that the forward H. P. and L. P. pistons went through the heads and a general smash up was started, which, but for the presence of mind of the chief engineer, John Hunter, and assistant Gavin M'Coll, would probably have caused, at least, a repetition of the disaster which befell the S.S. *Paris* several years ago.

In the accompanying drawing the arrangement of the cylinders of the *St. Paul's* engines is shown. The engines are of the six cylinder, four crank, quadruple expansion type, the high pressure and low pressure ends being each split up into two separate cylinders for convenience. The high pressure cylinders are tandem over the low pressure cylinders at the forward end, the first intermediate being at the after end and the second intermediate between.

Just at the instant the shock caused by the propeller dropping off occurred the chief engineer was in the alleyway on the starboard side close to the galley, in which was an emergency gear connected with a stop

AMERICAN LINER ST. PAUL APPROACHING THE ENTRANCE TO THE DRY DOCK IN THE BROOKLYN, N. Y., NAVY YARD FOR SURVEY OF DAMAGE SUSTAINED.
Photographed for Marine Engineering by E. Muller.

valve on the steam main. With remarkable presence of mind, without stopping to make any inquiry as to the character or extent of the damage, he was instantly inside the galley and shutting off the steam supply to the engine. This, of course, would not bring the engine to a standstill immediately, as the large receiver spaces in multiple expansion engines contain enough steam to carry the engine over several revolutions; but already there was another cool head below in the person of Assistant Engineer M'Coll also thinking out the best means of preventing further damage. Mr. M'Coll was on the starting platform, and to get to the reversing lever was the work of a moment. Throwing the links into mid position, while the gear was still operative, he let steam into both ends of the still intact intermediate cylinders, and the engine was stopped. Meanwhile the work of destruction was going on, cranks were bending, running

gear twisting and straining, and even as he stood at the lever, one of the forward slides was wrenched from its place on the column and hurled on to the platform, passing within a couple of inches of his body on its way.

STERN VIEW AMERICAN LINER ST. PAUL IN NAVY YARD DOCK—STARBOARD PROPELLER MISSING.
Photographed for Marine Engineering, by E. Muller.

A quick examination showed that there was no rupture of the skin plating and that no appreciable amount of water was coming in at the stern gland. A proper speeding down of the fans at once con-

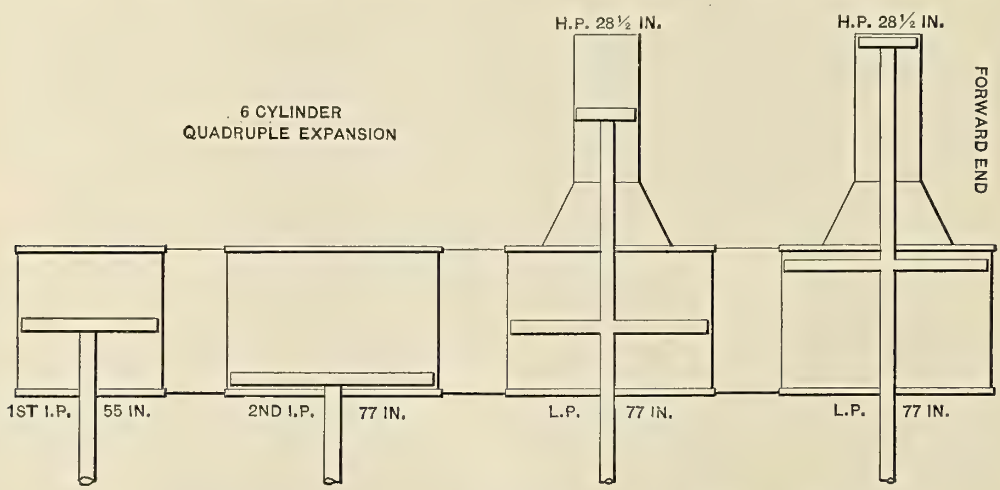
trolled the generation of steam in the boilers to the lessened demand and without stop or delay, other than the half power imposed, the *St. Paul* kept on her way to New York.

In engines of the type employed on the *St. Paul* governing by the throttle is impossible, and other automatic controlling apparatus is fitted direct to the reversing gear. Why the mechanism fitted on the vessel did not instantly respond to the decreased load has not been explained. Our readers will recall that on May 22 last, while bound west, the American liner *New York* dropped one of her propellers, and in that case the emergency gear instantly checked the engines and no inboard damage followed.

After the *St. Paul* reached New York permission was obtained from the government to dock her at the Brooklyn Navy Yard for an examination of the hull. In our engravings we show the liner at the dock entrance, and afterward in the dock with the starboard propeller missing. Little or no repairs were necessary in dock, and the *St. Paul* subsequently proceeded under her own steam to the yard of her builders (Cramps) at Philadelphia. The starboard engines will have to be taken adrift to determine just how much of the old work can be retained in the reconstruction.

It is particularly unfortunate that the mishap should have occurred at this time, when the *Philadelphia* (formerly *Paris*) is undergoing reconstruction, and not one of the new ships ordered by the line is ready for sea. Work on the Red Star liner *Vaterland*, now fitting out at Clydebank, will undoubtedly be rushed, so that the regular schedules of both the Red Star and American lines, operated by the International Navigation Co., may be maintained.

As a matter of convenience, we repeat the dimensions of the S.S. *St. Paul* and of her machinery. The dimensions are as follows: Length, 535 ft.; beam, 63 ft.; depth, 50 ft.; gross tonnage, 11,629. She is a steel twin screw vessel, built at Cramp's Shipyard, and she came out in the year 1895. The engines have cylinders—high pressure (two), 28 1-2 in.; first intermediate, 55 in.; second intermediate, 77 in.; and low pressure (two), 77 in. by 60 in. stroke. She has ten Scotch boilers, six double ended and four single ended, all of about 15 ft. 6 in. diameter. The boilers are worked with Howden draft, and the steam pressure carried is 200 lb. The engines are constructed with cast steel inverted Y columns, front and back, each column being made in halves, bolted together vertically. The high pressure piston rods are 6 in. dia. and the low pressure 8 1-2 in. dia. The connecting rods are 11 ft. 3 in. long between centers, 10 in. dia. at the crank ends, and 8 1-2 in. dia. at upper ends. The crank shaft bearings are 21 in. dia. and 31 1-2 in. long, with a 6 in. through hole. The piston rods are fitted with single slipper guides working in slides bolted to the inboard columns at the ends. The collective H. P. of the twin screw engines is about 20,000 I. H. P.



ARRANGEMENT OF CYLINDERS IN ENGINES OF AMERICAN LINER ST. PAUL.

CONDITIONS OF AMERICAN SHIPPING AS DISCLOSED IN U. S. OFFICIAL REPORT.

There is much encouragement for those who are doing the pioneer work in restoring the American merchant marine to its proper position among the merchant navies of the world in the report of the U. S. Bureau of Navigation for the past fiscal year, which will shortly be issued. An abstract of this report has been issued by Commissioner E. T. Chamberlain, which brings out many interesting points, both as to the actual condition of the merchant marine and as compared with the fleets of other nations.

"For the first time since the Civil War broke out the documented tonnage of the United States exceeds 5,000,000 gross tons. On June 30, 1900, American documented tonnage comprised 23,333 vessels of 5,164,839 gross tons, an increase of 300,000 tons over the previous fiscal year. Our maximum tonnage was 5,539,813 tons in 1861. (Our shipping was then larger than Great Britain's, and nearly equaled the British Empire's. British shipping now amounts to 14,261,000 gross tons.)

"American vessels are almost wholly confined to the coasting trade, which employed last year 4,338,145 tons, or more than the total tonnage of Germany and France. Our tonnage in the foreign trade was only

816,795 tons, and carried last year only 9 per cent of our exports and imports. A century ago American shipping registered for foreign trade was 669,921 tons, while this tonnage now in the 13 original States amounts to 482,907 tons.

"For serious competition with foreign nations in the ocean carrying trade we are practically restricted to 97 registered steamships over 1,000 tons, aggregating 260,325 tons. Single foreign steamship corporations own greater tonnage. Japan has 83 ocean steamships of over 2,000 tons, aggregating 286,000 tons. Besides these steamships we have 125 registered square-rigged sail vessels over 1,000 tons each for the deep-sea trade. More than half of these are over 20 years old, and as such vessels disappear their places are not supplied by new construction.

"Our tonnage is distributed, between the Atlantic and Gulf coasts, 2,727,892 gross tons; Great Lakes, 1,565,587 tons; Pacific Coast, including Hawaii, 612,904 tons; Mississippi and tributary rivers, 258,456 tons. Our steam vessels amount to 2,657,797 tons; documented canal boats and barges to 622,000 tons; and the remainder, 1,884,842 tons, are sail vessels and schooner barges.

"The increase in our shipping during the decade was 740,342 tons, of which 502,523 tons stand to the credit of the Great Lakes. The increase in ten years on the Pacific has been 184,512 tons, due mainly to Alaskan and Hawaiian trade, and on the Atlantic and Gulf Coasts only 89,297 tons, while the tonnage on the Mississippi and tributaries has decreased 36,000 tons.

"The report is chiefly devoted to the relations of the United States to the world's ocean carrying trade, and for this purpose changes in the world's shipping during the past ten years are examined in some detail. Since 1890 the world's steamships have increased from 12,985,000 gross tons to 22,369,000 gross tons, sail vessels have decreased from 9,166,000 tons to 6,674,000 tons, and the effective carrying power of the world's merchant fleets has increased 60 per cent.

"The most notable change in the world's shipping has been in the size of steamships. In 1890 there were 218 ocean steamships of 4,000 tons or over, while now 980 such steamships, aggregating 5,600,000 tons, constitute one-fourth of the world's steam tonnage.

"Increased speed, though great, has been less noteworthy. Of the ocean steam tonnage of 1890, 13 per cent, 423 screw steamships, of 1,650,000 tons, were of 12 knots or over. Of ocean steam tonnage in 1900, 24 per cent, 1,109 screw steamships, of 5,230,000 tons, are of 12 knots or over. The hulls of 60 per cent of the world's shipping are now made of steel.

"Concentration of the world's shipowning has been as notable during the decade as the centralization of shipbuilding. A list is printed of the 30 principal steamship companies of the world which own 1,600 steamships of 5,616,000 gross tons (including some vessels now building), or one-quarter in tonnage and more than one-quarter in carrying power of the world's ocean steamships. Of these only nine, of 81,000 tons, owned by the International Navigation Company, are American. Ocean carrying, through regular passenger and freight lines, is being assimilated to the methods and conditions of trunk railroad transportation.

"On the basis of the gross earnings reported by principal foreign steamship companies it is estimated that during 1899 the gross earnings of steam and sail vessels in the foreign carrying trade of all nations amounted to $700,000,000.

"The export trade of the United States requires about 20 per cent of the world's seagoing tonnage in foreign trade, including the largest, fastest and most expensive steamships. The weight of our exports by sea in 1899 was 24,000,000 tons, of 2,240 lb. To carry these exports and passengers, including immigrants, requires steady employment throughout the year of about 1,200 steamships aggregating 3,600,000 gross tons, and 1,300 sailing vessels of 1,000,000 tons. The number and tonnage of vessels actually engaged is, of course, larger, as, obviously, many vessels are engaged only part of the year in the trade of the United States.

"In the past ten years Great Britain has built 4,638 steel steamships of 9,793,000 tons, while the United States has built 465 steel steam vessels of 743,000 tons, of which 198 of 450,000 tons were built on the Great Lakes. Our entire construction for the decade is not much more than half of Great Britain's output of 1,340,000 tons during 1899. We have built for the foreign trade since 1890 only twenty-four steel steamships of 80,000 tons, and of this total eleven steamships of 58,000 tons were built as mail steamships under the postal subsidy acts.

"On August 15, 1900, sixty-eight steel merchant steam vessels, aggregating 278,000 tons, and forty-seven naval vessels, 113,000 tons (displacement), were building or contracted for. Contracts since that date (some since election not included in the report) bring the merchant total up to 350,000 tons, including about 100,000 tons on the Lakes. Congress has authorized 179,800 tons (displacement) of naval vessels, not yet contracted for. Part of the merchant construction will not be completed in two years or more, but the current year will record much the largest amount of steel shipbuilding in our history.

"A freight steamship carrying 5,000 tons cargo now costs $275,000 in the United States, compared with $214,0000 in Great Britain, though steel is much cheaper here than abroad. Besides lower labor cost, the British advantage lies in the enormous scale of production, Great Britain being the world's department store of shipping. Monthly wages on the American vessel are $1,200 against $900 on the British ship.

"On the basis of foreign voyages actually made by American vessels, aggregating 809,000 gross tons, during the calendar year 1899, the expenditures under the Senate subsidy bill would have been $2,907,000, and under the House bill, $2,790,000. Details and estimates show that, with the additional shipping eligible, the cost during the first year of the bill's operation would be about $4,500,000. The maximum of $9,000,000 would probably be attained during 1904-5, when a reduction of subsidy rates would be necessary. By that time the building of over 500,000 tons of ocean steamships, and the necessary increase in number and extent of our shipyards, would have materially reduced the cost of shipbuilding in the United States, compared with Great Britain and Germany. Under the bill, in five years, American steamships in foreign trade would, it is estimated, reach 1,200,000 tons, and sail vessels 650,000 tons, sufficient to carry about one-third of our ocean trade."

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As our readers will have observed, this issue contains a detailed account of the proceedings at the eighth general meeting of the Society of Naval Architects and Marine Engineers, which was brought to a successful though somewhat abrupt conclusion, so far as the technical sessions were concerned, on November 16. The real cause of this unusual endi g was the reading of a scurrilous attack upon the Author of a scientific paper by no less a person than a Member of the Council of the Society. After the paper on "Classification Rules" had been opened for scientific discussion the Member of the Council, who is also an official of the American Bureau of Shipping, rose to reply, and proceeded to read from a document which contained little of technical value but much of personal abuse and insult directed at the Author of the paper. More amazing still is the fact that the reading of this document passed unchallenged by the Chair or by any member present in the convention hall. At its conclusion the Author, who had kept a dignified silence, arose and, ignoring the insults and insinuations, confined himself to legitimate discussion. A more detailed account of this discussion will be found in our report of the meeting, though this has been expurgated. After some further discussion this Member of the Council had the effrontery to offer a motion, "in view of the misstatements and untruthfulness of the paper," that it and the "remarks" bearing upon it be excluded from the proceedings. This motion met, of course, with no support, but apparently prompted another motion, which was carried, that leave be given the Author of the paper and those who took part in the discussion to "eliminate personal remarks." This was adding injury to insult with a vengeance. This motion should never have been put in the form it was made in, and its passage was a public affront, not only to the Author of the paper, but to the distinguished Secretary of the Society. In the first place, there are no personalities contained in the paper, and in the second place, it has been the duty and privilege of the Secretary to see that papers presented are in accord with the ethics of the honorable profession of which he is a member. Then it was only a few hours previously that the President rightly assured the Meeting that the papers to be read "had been prepared by gentlemen whose abilities command the highest professional esteem," and the Society stultified itself by passing an omnibus order which classes the Author with one whose grossness of attack might have called out denunciation in a gathering of political heelers. In any view of the matter, what good purpose could be served by such a motion? Were a man so little a judge of the decencies of speech that he would use insult instead of argument unknowingly, how would he be put in a position to write politely by such an indefinite order? Were he blameless of any wrong doing the necessity for such order would not exist. In any rational consideration of such an offense it would in the first instance be necessary to particularize and point out to his vulgar comprehension the objectionable passages for excision, and in the other case the granting of such permission would be a gratuitous insult that might be resented, under certain readily conceivable circumstances, with Nature's weapons. And in the case of one who deliberately and with malice violated his confidence as an officer of the Society, and grossly outraged the hospitality which the Society should extend to members contributing to its proceedings, some disciplinary treatment would be in order. The Council of

the Society owes it to itself, and to the dignity and standing of the S. N. A. and M. E. among the kindred societies of the world, to probe this matter further and place itself on record as to the treatment to be accorded those Authors who decently attempt to add to the value of the Proceedings.

IT is the fashion among certain writers to bewail the disappearance of the "lofty masts and tapering spars" from the fleet ships of commerce, and to associate with this the decline of the poetry and romance of the seas. It is as well, perhaps, that they have gone, in large part, in the days of the "strenuous life," but in their place have come new forms in naval architecture and new types among those who go down to the sea in ships that in their own day and age have all the beauties and virtues of their predecessors. Some time the poet and the prose writer will awaken to this and in undying art will tell of the days of steam. We are put in this humor of thinking by contemplation of the act of Assistant Engineer M'Coll, of the American S.S. *St. Paul*, on her last westward trip. Fortune favored that ship when, by a seeming chance, Gavin M'Coll stood on the starting platform in the starboard engine room on that night of October 31. During the watch there had been no warning of coming danger. The engines were turning up with the smoothness for which the machinery of this and her sister ship are famous in the transatlantic trade. Then, in an instant, there was a shock, a startling interruption of the smoothness of rotative effort, and ten thousand horse power was turned loose in the cramped space of a liner's engine room. Down below the water line, alone, caged with an engine that, like some maddened prehistoric monster, was tearing its own members asunder, Engineer M'Coll had his choice. Through the door at his back, in the bulkhead, and up the port ladders lay immediate safety for himself, but what of the ship? He knew that over his head a seventeen-inch steam main might, if ruptured, boil him alive with two hundred pounds of steam, or that, pinned down by some of the falling machinery, he might drown like a rat in a flooded sewer were the sea connections carried away. A veteran, he well knew the risks, and he also knew what the safety of the ship and of her passengers demanded—his life, possibly. And with as much coolness and attention as though the order "Stand by!" had just been rung down before leaving the dock, he shifted the links and the uncontrolled forces were stilled. Even as he stood at the quadrant a half ton of metal passed within a hand's space of his body with the velocity of a projectile. In the day of battle, when the spirit of patriotism is aroused, when comrades in arms are joining in the common cause and the old flag is flying over head, a man will do a heroic deed that in calmer times he might find impossible. There was no such inspiration for Engineer M'Coll. Alone with unexpected disaster, with forces of enormous magnitude ready to overwhelm him, he faithfully performed his duty. We did not read of any testimonials prepared by grateful passengers, nor any official expressions of appreciation, though many a man has won the Thanks of Congress or the Victoria Cross for less. It would be fitting for the underwriters to take such action, and in a public place, say the floor of the Maritime Exchange, present to Gavin M'Coll some tangible sign of acknowledgment.

NOW that the Paris Exposition is a thing of the past, attention to such displays will be centered upon the Pan-American Exposition at Buffalo, New York, which will open its gates to the public May 1 next. Already the grounds and buildings have taken such shape that the magnificence and beauty of this all-America fair can be appreciated. A most interesting booklet has been issued by the management, giving details of the project and containing copies of photographs of the buildings and grounds, and those who have not examined this publication will benefit themselves by procuring a copy from the headquarters at Buffalo. Although the Exposition has been located outside of the principal cities of the country it will be of the first magnitude, its cost exclusive of the exhibits being estimated at ten million dollars. The location has the great advantage of being readily accessible by railway and by water transportation. At the Exposition there will be twenty or more main buildings, and the exhibits will be divided into about as many classes. Owing to the nearness of the Niagara Falls electric power plant, the management will be able to make a magnificent electric display which will include many new and beautiful effects. We hope the marine interests of the country will be worthily represented.

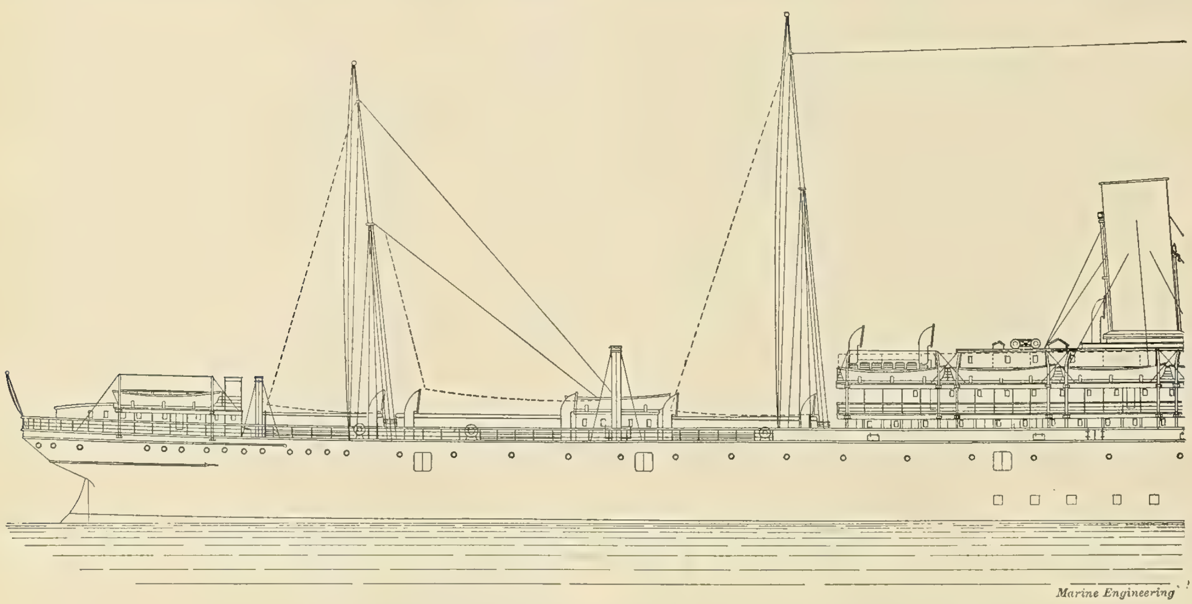
OCEAN STEAMSHIPS BUILDING FOR J. J. HILL AT NEW LONDON, CONN.

Many large passenger and cargo steamships have been built during the past few years. The *Campania* and *Lucania* of 12,950 tons gross register, the giants of 1893, have recently been dwarfed by such tremendous vessels as the *Kaiser Wilhelm der Grosse* of 14,349 tons, the *Deutschland* of 16,000 tons, and the *Oceanic* of 17,000 tons. Vessels are now being built in Europe that will exceed in size all the above mentioned; but not any of these steamships of which we can obtain accurate information, either built or projected, will equal in tonnage, displacement or carrying capacity the mammoth Pacific liners building for the Great Northern Steamship Company, by the Eastern Shipbuilding Company, of New London, Conn. These large new vessels, of which the keels are already laid, have been designed primarily for cargo carriers. They are not as long as some of the largest Atlantic liners, but are much wider and deeper. The following are their principal dimensions: Length, 630 ft.; beam, 73 ft. 6 in.; depth, 55 ft. 8 in.

These immense vessels will be of about 21,000 gross tons register and 33,000 tons displacement, or just 10,000 tons more displacement than the new Atlantic liner *Deutschland*. They have each five continuous decks extending the whole length of the ship, with three additional decks amidships.

The cubical carrying capacity of these ships is very great, and the holds are such that 28,000 tons of coal can be carried, excluding 4,500 tons carried in permanent bunkers. The dead weight carrying capacity at normal draft is stated as 20,000 tons. The vessels are fitted up for the accommodation of a large number of passengers. About 200 first cabin passengers will be carried in the amidship houses; 100 second cabin just abaft of the machinery below the weather deck; 200 third class forward of the machinery; and in the forward between decks, accommodation will be provided for about 1,000 steerage. As the crew will number about 250 men all told, the total number of berths fitted for the passengers and complement will be about 1,750.

Each vessel has a double bottom extending the whole length of the ship, over 6 ft. deep, and this is divided up into about thirty compartments. The main hull above the double bottom is divided up into twenty-five compartments, the vessel being practically unsinkable. Deep water tanks have been fitted in the between deck spaces for lessening stability at light draft and making the vessel easier in a seaway. Arrangements have been made for carrying cattle, also for chilled or frozen meats in refrigerating chambers, and fruit or any kind of cargo that may appear for transportation. As shown by the accompanying profile, the vessels have a very pleasing and businesslike appearance. They resemble somewhat the latest steamships built by Harland & Wolff, of Belfast, for the Atlantic intermediate carrying trade. The vessels have got substantial freeboard, four masts and one smoke pipe, well located and harmoniously arranged. For cargo carriers and money earning vessels, they are shapely, handsome vessels.



OUTBOARD PROFILE OF THE TWO OCEAN GOING STEAMSHIPS (33,000 TONS DISP.) UNDER

The propelling machinery consists of twin screws, vertical triple expansion surface condensing engines, with cylinders about 30 in., 54 in. and 90 in. by 54 in. stroke.

Steam will be generated by sixteen large water tube boilers of the Niclausse type, worked at forced draft. These boilers have a heating surface of over 40,000 sq. ft. The working pressure is 250 lb.

The general arrangement and details of these vessels are of particular interest, and interesting innovations can be seen on every hand. They are purely an American production, of American design and American construction, and will be owned and operated by an American steamship company. They will carry

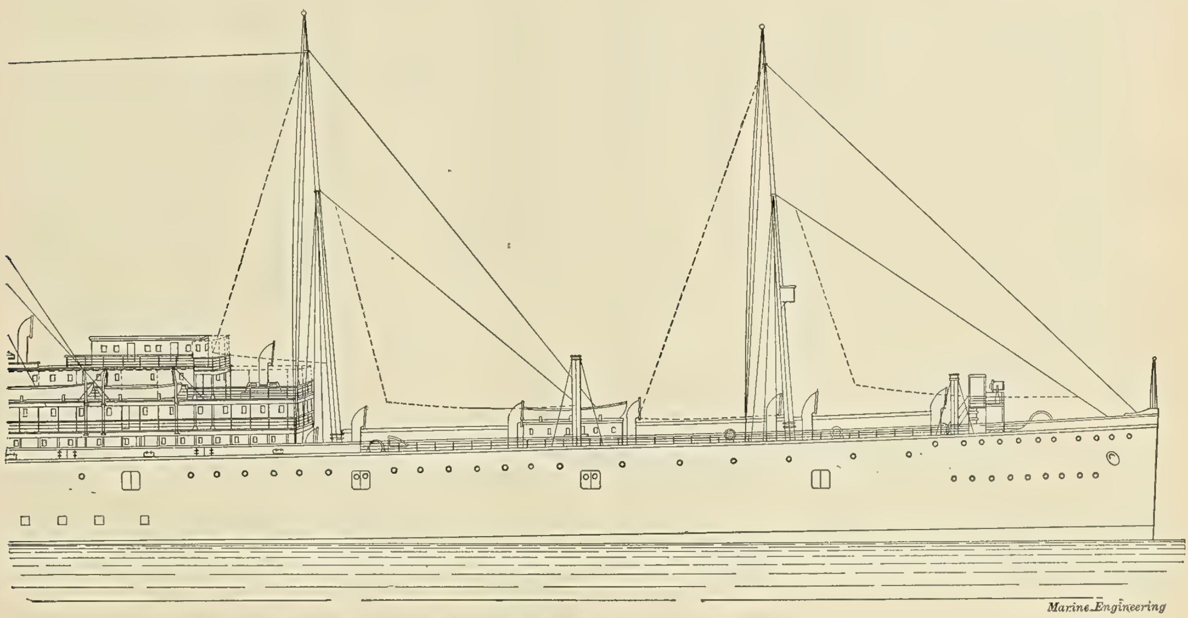
the produce of the western farms, mines and manufacturing companies of this country and distribute the same wherever there is a demand in the Orient.

The Eastern Shipbuilding Co., the builder of these mammoth vessels, is now completing the construction of a modern shipbuilding plant on the Thames river, opposite New London, Conn. The officers of the company are: Charles R. Hanscom, president; John Sherner Hoyt, treasurer; William A. Fairburn, naval architect and engineer; Charles Schofield, yard superintendent. The new Pacific liners are expected to be completed for the summer of 1902, and they will cost about $2,500,000 apiece.

NEW WHITE STAR LINER CELTIC.—Advices from Belfast, Ireland, report that work on the new monster vessel for the Liverpool-New York service of the White Star line is so far advanced that she will probably be launched before the close of the year. She is modeled after the *Oceanic*, and will have a somewhat similar appearance in the water, with two funnels, but will have four masts. Her gross measurement is 20,000 tons, which is 3,000 greater than the *Oceanic*. The boat, we are informed, will come under the intermediate class, and so will not break any transatlantic speed records.

According to Lloyds, there were 452 vessels of 1,204,008 tons built in the United Kingdom during the quarter ending September 30, 1700. This shows a reduction of over 60,000 tons as compared with the similar period in the year 1899. These figures do not include war vessels.

In his annual report, Rear Admiral Bradford, U. S. N., Chief of the Bureau of Equipment, recommends the installation of the Marconi system of wireless telegraphy on several U. S. naval vessels, provided the cost is not excessive.



CONSTRUCTION AT THE YARD OF THE EASTERN CONSTRUCTION CO., FOR J. J. HILL.

LAUNCHES—HOME AND FOREIGN.

U. S. S. ARKANSAS.—The monitor *Arkansas* was launched at the yard of the Newport News Shipbuilding & Dry Dock Company on November 10. The boat was christened by Miss Bobbie Newton Jones, daughter of Governor Jones, of Arkansas. Her dimensions are: Length on load water line, 252 ft.; extreme breadth, 50 ft.; mean draft, 12 ft. 6 in.; displacement, 3,235 tons; gross tonnage, 1,613.27 tons. Her armament consists of two high power 12-in. breech-loading rifles, a gun that has just been designed to be used with smokeless powder; four 4-in. rapid fire breech-loading rifles completing the main battery. The secondary battery consists of three 6-pdrs. rapid fire and four 1-pdr. automatic rifles. The *Arkansas* is one of four harbor defense vessels of the monitor type authorized by act of Congress of May 4, 1898.

S.S. GEORGETOWN.—The steel propeller *Georgetown*, the first ocean going boat ever built at Buffalo, was launched at the yard of the Union Dry Dock Co., Buffalo, N. Y. She was built for the Atlantic Coast Steamship Co., of New York, and is of these dimensions: Length, 258 ft.; beam, 40 ft.; moulded depth, 18 ft. 3 in. She is fitted with triple expansion engines and Scotch boilers. The *Georgetown* is a sister ship to the *Waccamaw*, which was built at Toledo.

U. S. S. PERRY.—The torpedo boat destroyer *Perry* was launched from the Union Iron Works, San Francisco, Cal., Oct. 27, the ceremony of christening being performed by Miss Maud O'Connor. The dimensions are: Length on load water line, 245 ft.; extreme breadth, 23 ft. 7¼ in.; mean draft, 6 ft. 6 in.; displacement, 420 tons, and gross tonnage, 508.93 tons. Her engines are twin screw of vertical inverted triple expansion type, and the boilers are Thornycroft water tube. She will carry two 3-in. R. F. guns, five 6-pdrs., and two 18-in. torpedo tubes.

U. S. S. Nevada.—The monitor *Nevada*, one of the four vessels of this class authorized by Congress in May, 1898, was launched at the yard of the Bath Iron Works, Bath, Me., last month. She was christened by Miss Annie Boutelle, of Bangor, daughter of Congressman Boutelle. This vessel was originally named the *Connecticut*, but owing to objections raised by the people of that State, who disapproved of the use of the name on a vessel of this type, the name was subsequently changed to the *Nevada*. This monitor is a sister ship of the *Arkansas*, *Florida* and *Wyoming*. She is of about 3,000 tons displacement and will carry two 12-in. guns and four 4-in. guns in the main battery. The contract date of completion is March 19, 1901.

U. S. S. Lawrence.—The torpedo boat destroyer *Lawrence* was launched at the yard of the Fore River Engine Co., at Weymouth, Mass., on November 7. The boat was christened by Miss Ruth Lawrence, a descendant of the naval hero, Commodore Lawrence, after whom the boat was named. The *Lawrence* is one of the sixteen destroyers authorized by Act of Congress of March 4, 1898, and is of these dimensions: Length on load water line, 242 ft. 3 in.; extreme beam, 22 ft. 3 in.; mean draft, 6 ft. 2⅛ in.; displacement, 400 tons, and gross tonnage, 431.20 tons. Her armament will consist of two long 18-in. Whitehead torpedo tubes, two 14-pdrs. and five 6-pdrs. R. F. guns.

Japanese Battleship Mikasa.—The Japanese battleship *Mikasa* was launched on November 8 at the Vickers-Maxim Works at Barrow, England. The *Mikasa* is of 15,200 tons displacement; she is 400 ft. long, 76 ft. wide, 27 ft. 3 in. deep. She has two propellers, and engines of 15,000 I. H. P. Her armament consists of four 12-in. guns, fourteen 6-in. quick firing guns, twenty 12-pdrs., eight 3-pdrs. and four 2-pdrs. She has four submerged torpedo tubes. The battleship has an estimated speed of 18 knots, and her normal coal supply is 1,400 tons. She carries a crew of 730 men. The *Mikasa* was christened by Baroness Hayashi, wife of the Japanese Ambassador to England.

U. S. S. De Long.—Mrs. Sophie De Long Miles went through the formality of naming the *De Long* on November 22, at Lawley's ship yard, South Boston, Mass., although the boat was not launched, the water at high tide being too low. She was launched privately on November 23. The *De Long* is one of the eight torpedo boats ordered by the government in the fall of 1898. She is named for George Washington De Long, Lieutenant-Commander of the U. S. Navy, the Arctic explorer. The vessel's dimensions are as follows: Length on load water line, 175 ft.; extreme breadth, 17 ft. 6 in.: mean draft, 4 ft. 8 in.; displacement, 165 tons; gross tonnage, 226.18 tons.

S.S. Orion.—The wooden steamship of about 3,000 tons capacity was launched recently at Green Bay, Wis. Her dimensions are: Length over all, 282 ft.; beam, 42 ft. 23 in.; depth amidships, 16 ft. The hull is very strongly braced with steel members, and the vessel will have eight hatches and two masts. She will be fitted by compound engines built by H. G. Trout, of Buffalo, and a Scotch boiler built at Ferrysburg, Mich.

Ferry Boat West Point.—The ferry boat *West Point* for service in connection with the West Shore Railroad in New York harbor was launched at the ship yard of Thomas S. Marvel & Co., Newburgh on the Hudson, November 10. The vessel is built of steel and will be fitted with double screws—one screw at each end. Her dimensions are: Length, 208 ft.; beam, 40 ft.; depth of hold, 18 ft. She will be fitted with vertical engines and boilers of the Scotch type. The machinery is being constructed by the W. & A. Fletcher Co., Hoboken, N. J.

Tug S. R. Callaway.—The steel tug *S. R. Callaway*, built for the Vanderbilt railroad interests, was launched at the yard of Thomas S. Marvel & Co., Newburgh on the Hudson, November 10. Miss Callaway, daughter of the president of the New York Central Railroad, christened the boat with the customary bottle of champagne. The tug is of these dimensions: Length, 105 ft.; beam, 24 ft.; depth of hold, 11 ft. She will be fitted with compound engines 20 in. and 40 in. by 26 in., and will be used both for inside and outside towing in New York harbor.

S.S. Hawaiian.—The big freighter *Hawaiian* of the American-Hawaiian Steamship Company was launched at Roach's ship yard, Chester, Pa., on November 7. Mrs. W. C. Sproul, wife of the State Senator from Delaware county, christened the vessel. The new boat is one of a fleet of seven steamers. Her dimensions are: Length, 435 ft.; beam, 51 ft.; depth, 33 ft. to water bottom. Her gross tonnage will be 6,000, and she is fitted with triple expansion engines of 2,500 H. P., and will carry 8,250 tons of freight.

U. S. S. Blakely.—The torpedo boat *Blakely* was launched on November 22 at the works of George Lawley & Son, South Boston, Mass. The *Blakely* is named for Captain Johnston Blakely, who became famous as commander of the fighting ship *Wasp* in the war of 1812. She was christened by Miss Nellie M. White, of Winchendon Springs. The dimensions are: Length on load water line, 175 ft.; extreme breadth, 17 ft. 6 in.; mean draft, 4 ft. 8 in.; displacement, 165 tons; gross tonnage, 224.18 tons.

S.S. General Frisbie.—Steamer *General Frisbie*, built for the Monticello Steamship Company of California, was launched at the Bellingham Bay Improvement Company's yard, New Whatcom, Wash., on November 15. The dimensions of the *General Frisbie* are as follows: Keel, 160 ft.; over all, 170 ft.; beam, 25 1-2 ft.; hold, 13 ft.; H. P. of engines, 1,200. She is designed for a fast day excursion boat and will carry 800 passengers.

S.S. Runic.—The steamship *Runic*, building for the White Star Line, was launched at the yard of Harland & Wolff, Belfast, Ireland, October 25. The *Runic* is designed for trade between England and South America and Australia, and is one of the largest passenger steamers afloat. She is of these dimensions: Length, 565 ft.; beam, 64 ft.; gross tonnage, 12,400 tons.

Tug Chauncey M. Depew.—The seagoing tug *Chauncey M. Depew*, the companion boat to the *S. R. Callaway*, was launched November 27 from the ship yard of Thomas S. Marvel & Co. The *Depew* is 105 ft. long, 24 ft. beam, and 11 ft. 9 in. deep.

H. M. S. Racehorse.—H. M. S. *Racehorse* was launched on November 8 from the Hebburn shipbuilding yard on the east coast of England. The *Racehorse* is one of three similar vessels now under construction, and is one of the latest type of torpedo boat destroyers. Her length is 210 ft.; breadth, 21 ft.; depth, 12 ft. 6 in., with a displacement of 316 tons. The armament consists of one 12-pdr. and five 6-pdr. quick firing guns, and two deck torpedo tubes.

Sch. Louise B. Crary.—The five masted schooner *Louise B. Crary* was launched from the yards of the New England Shipbuilding Company, Bath, Me., on November 20. She was christened by Mrs. Louise B. Crary, wife of T. B. Crary, one of the principal owners, of Binghamton, N. Y. The vessel's dimensions are: Keel, 250 ft.; beam, 46 ft.; length of masts, 115 ft.; gross tonnage, 2,331.

S.S. John J. Albright.—A 6,000 ton steel steamer built by the American Shipbuilding Co., at Cleveland, for Captain John Mitchell and associates, was launched November 3. This vessel measures: Length, 436 ft.; beam, 50 ft.; depth, 28 ft. She will be fitted with triple expansion engines, with cylinders 23 in., 37 1-2 in., and 63 in. by 42 in. stroke, and with three Scotch boilers.

Dredge Seattle.—The dredge *Seattle*, which is probably the largest and most expensive dredger ever constructed on Puget Sound, was launched from the yard of the Seattle Bridge Co. recently. She is to be used in the Government dredging of Everett harbor. The *Seattle* is of these dimensions: Length, 145 ft.; beam, 34 ft., and 12 ft. 6 in. between deck and keel.

Floating Dock.—A large sectional dry dock was launched recently from the yards of the Brewer Dry Dock Company at Elm Park, Borough of Richmond, Staten Island. It was the first dry dock ever built on Staten Island. The dock is 176 ft. long, with outriggers of 30 ft. on either side, and is 80 ft. wide and 35 ft. high, with a lifting capacity of 2,500 tons.

Sch. Oliver J. Olson.—The four masted schooner *Oliver J. Olson* was launched at Lindstrum Bros.' shipyard, Aberdeen, Wash., on November 10. She was christened by Miss Anna Knudson, one of the city's school teachers. The dimensions of the schooner are as follows: Length, 188 ft.; breadth, 38 ft. 6 in.; depth of hold, 14 ft.; displacement, 650 tons.

Sch. Clifford N. Carver.—The four masted schooner *Clifford N. Carver* was launched from the yard of the New England Co. at Bath, Me. She was christened by Miss Myrtle Thompson. The new vessel is of these dimensions: Length, 173 ft.; beam, 39 ft.; depth, 18 ft.; gross tonnage, 1,100 tons. The *Carver* is intended for coastwise trade.

Launch Major Symonds.—A wooden hull steam launch for the use of the U. S. Engineer of Buffalo, N. Y., was launched at the yard of Hingston & Woods last month. This boat is 68 ft. in length and will be used in connection with the harbor improvement work at Buffalo.

Sch. Ella F. Cripps.—The large bay schooner *Ella F. Cripps* was launched at the yard of Kirby & Sons, St. Michaels, Md., on November 2.

Barges Loyalty and Liberty.—Two steel tow barges for use in salt water trade to accompany the steamships *Paraguay* and *Ascunsion* were launched recently at West Superior, Wis. The steamships and barges are under the management of A. B. Wolvin, of Duluth, Mich. They will probably be put in service in the coast coal trade.

Sch. Republic.—The schooner *Republic* was launched from the ship yard of Dunn & Eliot, Thomaston, Me., on November 7. She was christened by Miss Ida Elliot, daughter of the builder. The *Republic* is a staunchly built vessel, and her dimensions are as follows: Length, 174.4; breadth, 38.2; depth, 17.9; gross tonnage, 801.95.

Dredge Sabine.—The U. S. twin screw hydraulic dredging ship *Sabine* was launched from the new ship yard of the Townsend & Downey Shipbuilding & Repair Co., Shooters Island, N. Y., on Nov. 24. This vessel will be used in connection with the work of harbor improvement at New York.

S.S. Indian.—The steamer *Indian* was launched at Belfast, Ireland, recently for the West India & Pacific Steamship Company. The steamer was specially built for the New Orleans-Liverpool trade. She is 482 ft. long; 57 ft. beam; 42.10 ft. depth of hold; gross tonnage about 9,200.

Sch. Fannie Palmer.—The five masted schooner *Fannie Palmer* was launched at the yard of George L. Welt, Waldoboro, Me., on November 8. The vessel is of these dimensions: Length of keel, 257 ft.; beam, 44 ft. 6 in.; depth of hold, 25 ft.; gross tonnage, 3,700 tons.

S.S. City of Everett.—The steamer *City of Everett*, built by the Seattle & Everett Navigation Co., at the Sumner Iron Works of Everett, Wash., was launched recently. The steamer was presented with a handsome set of colors by the citizens of Everett.

A settlement has been reached in the armor plate dispute by which the steel companies are to receive $420 a ton for Krupp armor. The Krupp process involves the Harvey patent, the validity of which is now under consideration by the courts, and it is agreed between the manufacturers and the government that the latter will assume in addition any liability for the Krupp process not exceeding $24.32 a ton for the Krupp royalty, and not exceeding $11.20 a ton for the Harvey royalty. The maximum price to the government is, therefore, $455.52, subject to diminution in case of any reduction in the royalties. The former bids of the companies now in agreement were $490 for this class of armor, and the original price asked was $545.

In his annual report, Chief Constructor Philip Hichborn, U. S. N., makes a plea for the construction of war vessels in the navy yards, so that the yard staffs may be kept as complete and efficient as naval organization requires. He points out that in foreign countries this practice is carried out extensively. The number of war vessels building in government dock yards at the present time is given as: England, sixteen; France, seventeen; Germany, eight; Russia, six; Italy, three.

CHARLES H. HASWELL, M.E.

BY GEORGE W. BAIRD, U. S. N.

The subject of this sketch is probably the oldest engineer now living, having been born in New York City, May 22, 1809. He received a classical education at the Jamaica (L. I.) Academy, and practical mechanical training at the West Point Foundry, N. Y., and Allaire Works, N. Y. He was a skilful draughtsman at an early age, and possessed of exquisite taste in the matter of beauty of design.

He entered the Navy as a chief engineer at the age of twenty-seven; it was before the creation of an Engineer Corps, in the time when engineers were employed in the Navy for limited periods, or for a cruise, and in the day when tacks-and-sheets were supreme. Steam, as a motive power, was not only held as an innovation, but unbecoming to a "man-of-war." As the boilers pretty well filled the main hold, displacing water and provisions, it was not expected that the innovation would be of long duration.

The first steamship was built for the Navy in 1814; she was blown up by her own magazine in 1829, without ever having gone outside of Sandy Hook. The second steam vessel was the *Sea Gull*, 150 tons, purchased in 1822, and sold in 1840. The *Poinsett*, the third steamer, 250 tons, was built in 1840, and transferred to the War Department in 1845. So, when Mr. Haswell entered the Navy, there was but one steamship in it. He had more or less to do with the building of all the steamers for the Navy (twenty-seven in number) up to 1852, when he severed his connection with the Navy and opened an office in New York as consulting engineer.

He was appointed Engineer-in-Chief of the Navy in 1836; at that time the Navy Department was managed by the "Board of Commissioners," and the constructors, engineers and draughtsmen, and clerks, were all subordinate to that Board. At that time it was not the custom to draw details on paper; indeed, general plans were sometimes but sketches, and the details were drawn upon wooden boards in the shops. For a time, Mr. Haswell had but one draughtsman and but one clerk to help him, and found it imperative to lead in both draughting and clerical work; the routine work of the office, the records of the steamers, the requisitions from and supplies for those vessels, were subjects that all passed over his desk. The prejudice against engines, and against the engineer, in that day, was intense; that, however, was but natural, for with the new motive power came the black coal to soil the sacred quarterdeck, and with it came the premonition that the glory of seamanship was waning; the fight between coal whips and tacks-and-sheets had been initiated.

Congress, in its wisdom, sought, at that time, the best engineering talent the country afforded. Commodore Stockton brought Mr. Ericsson to the Navy Department in 1842, and he was employed to design the engine of the *Princeton*. Mr. Copeland, the principal engineer of the Navy, was employed to design the *Michigan, Mississippi, Susquehanna* and *Saranac*; but both of those engineers complained of interference and hardships imposed by the Commissioners. Mr. Haswell, alive to the needs of the service, advised competitive designs, and often plead for money for experiments, urging that the cost of such experiments could only be borne by a Government. The machinery of the *Missouri*, a sister ship of the *Mississippi*, was designed by Mr. Haswell; the two vessels were equally efficient. The machinery of the *Powhatan*, a sister ship of the *Susquehanna*, was designed by Mr. Haswell; the two vessels were equally efficient. Both of these vessels had double inclined engines (according to Mr. Copeland's patents), and the leading dimensions were nearly identical; they differed only in detail. They were the first paddle wheel engines to have wrought iron frames and adjustable cut-offs. Every one of the above named vessels was eminently successful; so well were the details worked out that I doubt if they could to-day be excelled if the same conditions were imposed (pressure, jet condenser, speed of piston, etc.) as then prevailed.

Mr. Haswell was an early advocate of the screw propeller for war vessels. In this, he was opposed by many of the best engineers, and he felt himself between two fires, the sailor element on one side, and the engineers on the other. In 1848, two similar ships were laid down, the *Saranac* to have paddles, and the *San Jacinto* to have a screw propeller. Mr. Copeland designed the engine of the former, and Mr. Haswell of the latter. Mr. Haswell was overruled by the constructor, whose decision was confirmed by the Board of Commissioners, and he was thus obliged to run the propeller shaft through the stern to one side of the stern post; it was held that to cut the stern post would weaken the ship. The whole plan of the engine was essentially new; inventions were necessary to meet new contingencies, and some mistakes were made in the details. So the *Saranac* proved the better of the two, and, for a time, the paddle wheel was held to be the superior. But, ultimately, the *San Jacinto* was so improved that she beat the *Saranac's* best record.

Mr. Haswell was the first man to use zinc to prevent the internal corrosion of boilers. He designed the first steam launch (1837) ever built, and urged the Department to use this type of boat.

In 1842, the Navy Department was reorganized; the Board of Commissioners was succeeded by the Bureaus. The Engineer-in-Chief was placed under the Chief of the Bureau of Construction, and thus the number of persons who might overrule him was greatly diminished. He then, very wisely, began the task of creating an Engineer Corps in the Navy. It had been already found, on board the steamboats in the river trade, that a complete divorce between the "deck" and "engine department" was essential to success, viewed from a stockholder's standpoint. Besides that, trades, arts and crafts were rapidly running to specialties: "to be a good engineer," Mr. Haswell said, "one must be first an engine builder, and, second, an engine designer." He so laid down the prerequisites for their qualifications and examination, and in 1844 he was able to enlist the aid of the whole Navy Department, and then Congress established the Engineer Corps of the Navy. On these lines, the service was able to procure the best talent the country afforded; that corps existed during three wars. The records show that about 20 per cent of the applicants

MODEL FOR BRONZE BUST OF CHARLES H. HASWELL, M.E., TO BE PLACED IN SMITHSONIAN INSTITUTION.

gained admission; about 50 per cent of these were promoted to second assistant; and only about 50 per cent of the remainder reached the grade of chief engineer. Mr. Haswell rightly devised a method of promotion by selection, without the usual objections. "With such a system," he said, "we will get a superior class of chief engineers, who belong in the category of self-made men."

In 1855-7, Mr. Haswell was a member of the civic Board of Councilmen of the City of New York, and was its president in 1858.

In 1862-3, he was in command of an army transport steamer in the Burnside expedition, and, in the attack on Roanoke Island, he ran his vessel under fire (Fort Baxter) to the assistance of the gunboat *Ranger*, and pulled her off the shoal on which she had grounded.

For many years he was surveyor of steamers for the underwriters at New York, Boston and Philadelphia. He designed and located the buildings on Hoffman Island (New York Harbor), the crib bulkhead at Hart's Island, and the foundations of some large buildings in New York City. He is now consulting engineer for the New York Board of Public Works, and is also superintending the extensive constructions and improvements at Riker's Island.

He is the author of the famous mechanic's pocket book, now in its sixty-fourth edition—that book, which made the elements of engineering so easy to many of us, and which so delighted the Emperor of Russia that he sent Mr. Haswell a diamond ring. There was not then, nor is there now, a decoration for an engineer. For the soldier who destroys life, or the physician who saves it, there is a decoration in Russia, which may be given to foreigners. In the great art emporiums of Europe there are countless memorials of men who were famous in all other arts and sciences than that of mechanical engineering. It is true that the profession is young, but it has done the work of giants in its youth.

A few months ago I sent a circular letter to Mr. Haswell's friends, those in the Navy and out of it, which has brought sufficient contributions to enable me to have made a very fine bronze bust of Mr. Haswell, as he appears at the age of ninety-one. This will be placed in the Smithsonian Institution at Washington, with those of Fulton, Ericsson and Stevens.

Mr. Haswell has always been held in high esteem by engineers. Once, when Mr. Ericsson declined to be a Commissioner to the Paris Exposition, he was asked to recommend a man; he named Mr. Haswell, and said: "Very few professional men combine such perfect practical and theoretical knowledge as Mr. Haswell."

Mr. Isherwood, that master of engineering, once said: "At that period" (referring to Mr. Haswell's incumbency of Engineer-in-Chief of the Navy) "marine engineering was in its infancy; it had no science and but little art. Mr. Haswell added the former, and greatly improved the latter. His designs are still admirable, and the beauty and propriety of their details, most of them entirely original, testify to his professional skill."

SUBMARINE BOATS—FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.—III.*

BY CARL BUSLEY.

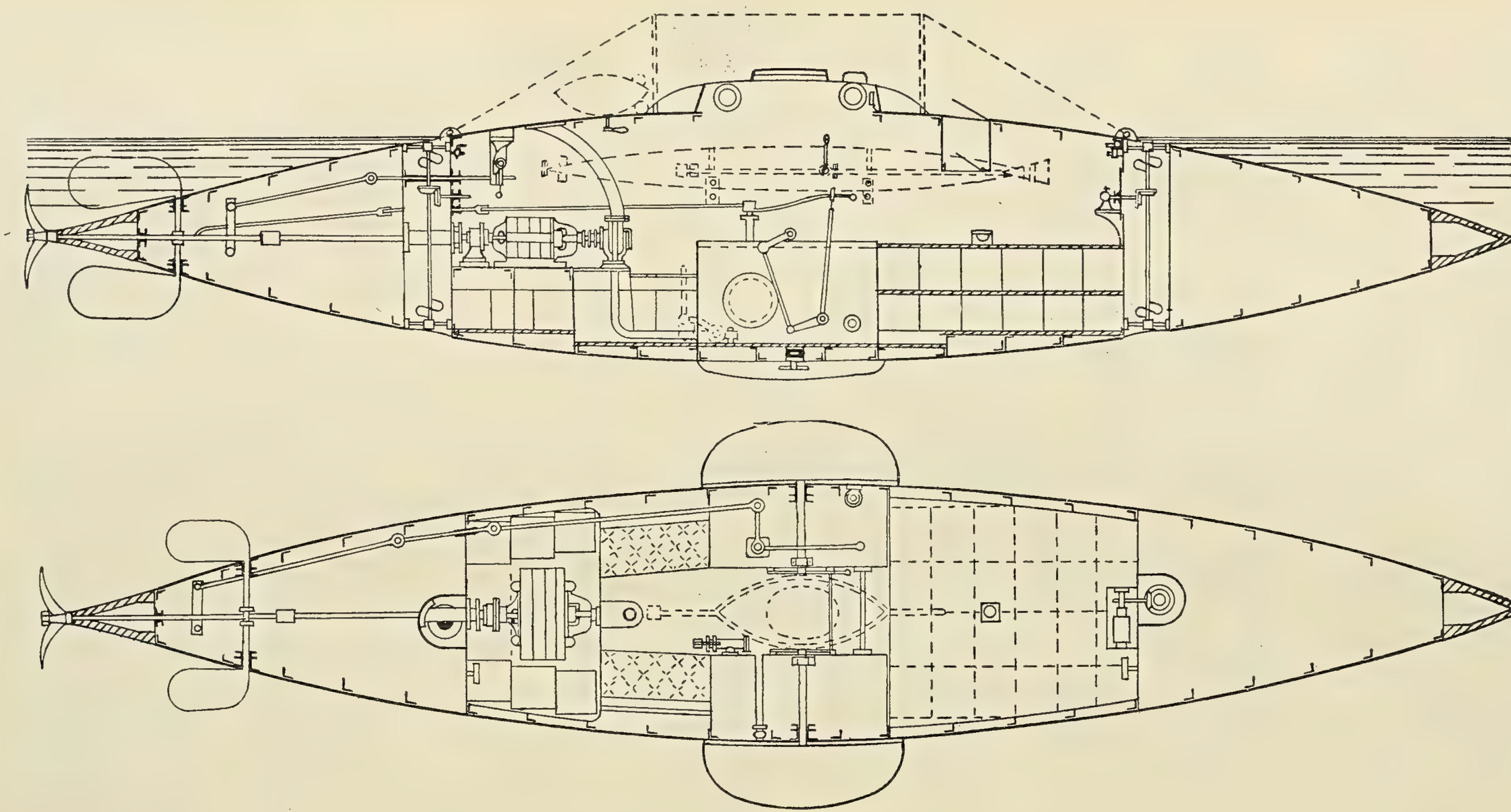
CHAPTER XIII.

Waddington's Porpoise, 1886.—In 1886 there was placed on exhibition at the exposition at Liverpool, a submarine boat as shown in Figs. 25 and 26, designed by an Englishman named Waddington. It was 35 ft. long and 5 3-4 ft. dia. amidships, and was fitted with four vertical propellers, two on a shaft, one set near the bow, and one near the stern, and also two horizontal rudders amidships, with the necessary hand levers to operate them, as shown in Fig. 26. The same drawing shows also the horizontal rudders attached to the after end of the boat, which were held in position by pendulums, with the intention of correcting any heavy pitch by the rudders amidships. The conning tower was equipped with a vertical rudder similar to the after horizontal rudder. The motor current for driving the propeller was furnished by 45 storage batteries. These were sufficient to develop 8 horse power for ten hours, and gave the boat a speed of 8 knots when she floated on the surface. The motors also drove the centrifugal ballast pump. Each of the two pairs of vertical propellers also had its separate electric motor. Each end of the boat was fitted with a receptacle for compressed air, which was to be used solely for renewing the air in case this became necessary. Under ordinary conditions, however, the two men of the crew could remain inside for a time of six hours without requiring a renewal of air. The weapons of the *Porpoise* were two Whitehead torpedoes, which were carried alongside, as shown by the dotted lines (Fig. 25), and which could be released by means of levers. The trials of the *Porpoise* when sailing on the surface were satisfactory, but nothing is known of her trials under water, so that the conclusion generally accepted is that such trials were never attempted, or if attempted were so unsatisfactory that the details were not made public.

CHAPTER XIV.

Campbell's Nautilus, 1886.—On the 27th of November, 1886, the submarine boat shown in Figs. 27 to 29 was tried in the West India Docks, in London. This boat, designed by Andrew Campbell, and built by Wolesly & Lyon, had a length of 57 ft. and a maximum dia. of 7 1-2 ft. and a displacement of 52 tons when fully submerged. The twin propellers were driven by two motors of 45 horse power, which were designed by Graydon Poor and built by Lewis Olrick & Co. The electric current was stored in 180 Elwell-Parker storage batteries, and these were systematically arranged on both sides amidships. The vessel was built of plate with angle iron frames. The interesting part of this boat lies in the system of increasing or decreasing her displacement as a means of diving or coming to the surface. Four horizontal cylinders of 20 in. dia. were fitted on either side, and these could be pushed out about 20 in. so as to increase the displacement by about one half a ton. This telescopic action was connected to the power plant, and the speed by which the displacement could be altered was sup-

*Translated from the proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany



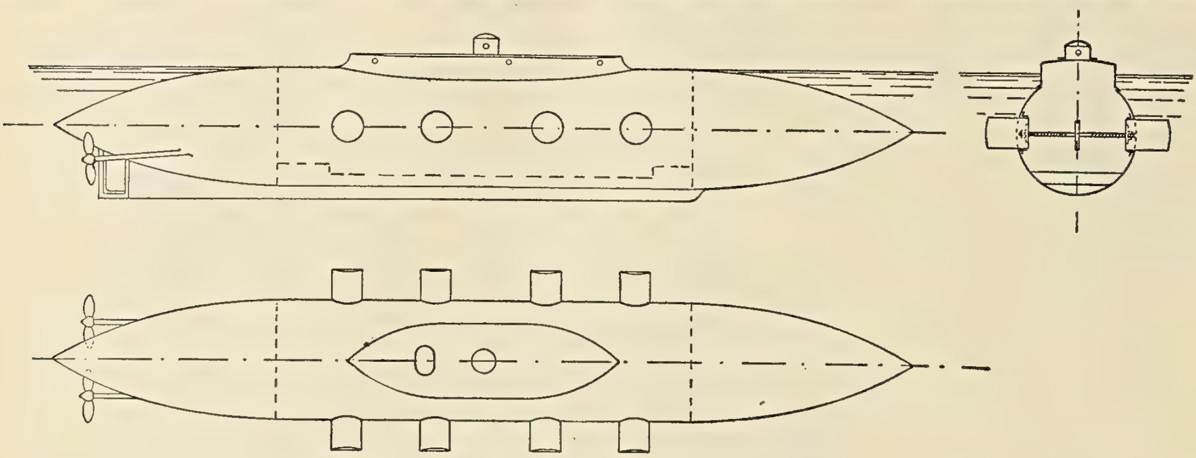
FIGS. 25 AND 26.—WADDINGTON'S PORPOISE, 1886.

posed to give quick results as far as the diving and raising action was concerned. Unfortunately, there are no reports of the performances of this boat further than that she went down 15 ft. to the bottom of the dock in a horizontal position, and also made several short trips below. Naturally, the projecting cylinders were a serious detriment to speed, and it can hardly be believed that the boat made a speed of eight miles an hour when submerged, as had been promised by the makers of the 45-horse power motors. After the few first trials nothing further was ever heard of the boat.

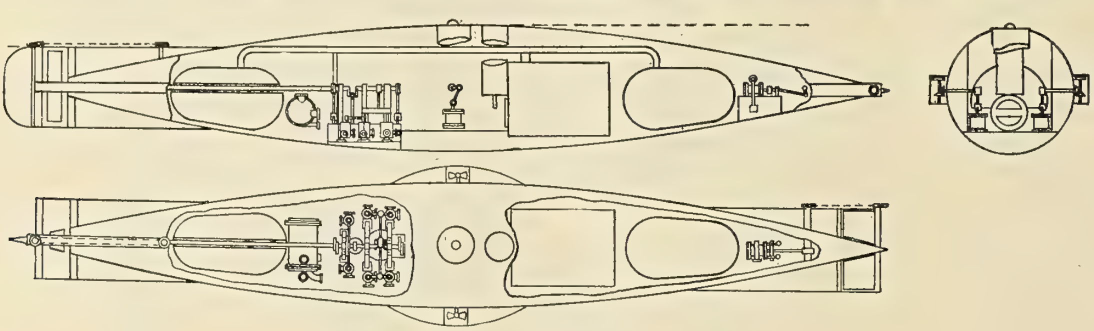
CHAPTER XV.

Nordenfelt's Boat, 1885.—In September, 1885, in Landskrona, the Swedish engineer, Nordenfelt, tried his submarine boat in the presence of a number of representatives of different navies. He built this vessel in 1883-1884, at Hartlwick, by Stockholm. It was built of mild steel, 64 ft. long, 9 ft. beam, 12 ft. depth, and when totally submerged it had a displacement of 60 tons (Figs. 30 and 32). The manhole at the top

center was fitted with a small glass observation tower about a foot high, from which the operator could make his observations. At the after end the boat was fitted with a four-bladed screw propeller, and a vertical rudder, and at the forward end there were two horizontal rudders, one on each side, and connected by balance weights. The duty of the latter was to bring the boat back to the horizontal position whenever it should happen to incline. The interior of the boat was divided into five compartments, of which the forward and after compartments contained a tank for water under high pressure and temperature. The crew occupied the central compartment, and the two others contained the engine and boiler. The engine was a compound of 100 I. H. P., and fitted with a surface condenser. Steam was generated in an ordinary Scotch boiler with a coal fire when the boat sailed on the surface, and was taken from the two pressure tanks when sailing below. The details of this system will be more fully explained in the following chapter on the Turkish boats. Nordenfelt declared that his boat could attain a speed of 14 knots under water when using the steam from the storage tanks. When the boat floated on the surface, a small ventilating fan driven by a small engine was used to force air into the compartments and reduce the high temperature caused by the steam machinery. When submerged, the same effect was expected to be produced by a circulation of cold water, although the temperature did rise as high as 90 deg. The enclosed air was sufficient to last six hours for the crew of three men. In order to submerge the boat the double bottom was flooded to such an extent that only a small flotative capacity was left in the craft, and this was counteracted by the vertical diving propellers similar to Bushnell's. These propellers were fitted either side of the boat at the middle—(Fig. 32)—and were operated by a small 6 H. P. engine. The steam pipe to this small engine was fitted with a throttle valve which was connected by means of links to a piston. This piston had the pressure of the outside water on one side and the pressure of a graduated lever with a weight, on the other side. By means of this arrangement it was intended to regulate the depth of the submersion of the boat by shifting the position of the weight on the lever, thus regulating the speed of the diving propellers.



FIGS. 27, 28 AND 29.—CAMPBELL'S NAUTILUS, 1886.



FIGS. 30, 31 AND 32.—NORDENFELT'S BOAT, 1885.

Turbine Driven Vessels.—In response to criticism regarding the coal consumption in turbine driven vessels, Charles A. Parsons has made a statement of facts and figures, which is distinctly favorable to the turbine system. In the case of H. M. S. *Viper*, of over 36 knots maximum speed, the coal consumption at 31 knots, official trial, was 2.38 lb. per I. H. P. per hour. On another trial, with the air pressure limited to 3 1-2 in., a mean speed of 33.83 knots was maintained with about one-fifth of the maximum power, with coal consumption at the rate of 2.49 lb. per I. H. P. per hour. In this vessel speed rather than fuel economy was the result sought, the inventor states, but in future vessels he hopes to be able to beat all previous records as to economy in coal. The economy of the *Viper* was equal to that of the ordinary 30-knot destroyer.

TECHNICAL PUBLICATIONS.

INJECTORS: THEIR THEORY, CONSTRUCTION AND WORKING. By W. W. F. Pullen. Second Edition. The Technical Publishing Co., Ltd., Manchester. Size, 5 by 7 1-4. Pages 187. With many illustrations. Price, $1.50.

The working of an injector, especially one of modern type, is a subject on which comparatively few engineers can give exact information, and is entirely a matter of mystery to the uninitiated. In this very concise and carefully written book the Author has given lucid explanations of all questions, both as to action and design. The first chapter opens with a popular explanation of the action of the steam injector. Then follows a mathematical investigation of the velocity of efflux of the steam jet. For those who are not able to follow the mathematical deductions, a series of tables have been constructed giving the principal data and results which may be needed in calculations of sizes and capacities. In the large number of illustrations the Author has endeavored to give examples of the different forms rather than examples of each manufacturer's apparatus. Of the examples given comparatively few are of American origin. This, the Author states, is due to the difficulty of obtaining such, together with the impossibility of consulting any American patent records. The first nine chapters deal with the elementary principles, calculations and sizes of cones, working limits, weights of water delivered. Then follow the descriptions of the simple nonlifting injector, its adaption to different kinds of locomotive work, with the gradual improvements. Then follow the lifting, automatic and retarding injectors and modifications of the same. The chapter on exhaust and compound injectors is very complete. Different styles of ejector condensers are shown, also their calculations and efficiency, and a short article on steam injectors for air blast. The chapter on air ejectors for producing vacuum for railway brakes is well illustrated, and several styles of injector for oil burning in marine boiler furnaces are also mentioned.

ENGINE TESTS. By George H. Barrus, S.B. First Edition. D. Van Nostrand Co., New York. Size 6 by 9 1-2. Pages 339. With numerous illustrations. Price, $4.00.

All who are interested in the economical development of power by means of steam boilers and engines will doubtless remember Mr. Barrus's "Boiler Tests" published in 1891. The favorable reception accorded this collection of boiler test results has lead the Author to prepare and publish a series of similar results drawn from his tests of steam engines. The book, as a whole, is divided into two parts. In the first of these the general subject of engine testing is considered in an instructive manner, and a description is given of the methods used by the Author, together with references to the use of indicators, the working up of results, the calibration of instruments, etc. In the second part is found the collection of results classified according to the type of engine under consideration. This is followed by a general review of the results given by the tests, including a discussion of the following topics: Cylinder condensation and leakage; effect of pressure on economy; economy of condensing; effect of superheating; relative economy of simple, compound and triple expansion engines; economy of steam jacketing and reheating in compound engines; effect of ratio of cylinder areas in compound engines, etc. This is followed by a section on valve setting by the aid of the indicator, and by a collection of steam-pipe diagrams showing the fluctuations of steam pressure in the pipe during the revolution of the engine.

Returning to the actual tests, the results in each case are collected and shown in tabular form followed by a brief explanation of any special circumstances which may have been present. Sample indicator cards are also shown, thus adding greatly to the value and interest of the results obtained. The experimental part of the work seems to have been well planned and carried out, so far as may be judged from the description of methods used, and the tests cover all the leading types of engines employed in stationary practice. The results will therefore be of the widest interest to all who are concerned with this field of engineering and especially to those who may have to deal with the design and installation of stationary central station or power plants. The book is well printed, and the indicator diagrams with which its pages abound are of good size, well selected, and well executed as examples of the engraver's and printer's art.

A new technical publication, *The Power Quarterly*, has just been issued to fill a demand for recent copies of *Power* containing matter on this subject. The *Quarterly* contains a complete synopsis of gas engines in foreign countries, as shown at the Paris Exposition, including a description of a gas engine operated by blast furnace gas (18 pages, 49 illustrations), a technical description of the leading American gas engines (23 pages, 77 illustrations), a reprint of the serial in *Power* on the principles of the construction and operation of gas engines (20 pages, 30 illustrations), an illustrated description of a producer plant for the manufacture of gas for gas engine purposes, editorials on the efficiency of the gas engine and its commercial advantages, and other matter relative to industry. Copies can be had for twenty-five cents each by addressing the Power Publishing Co., 145-148 World Building, New York.

The "Practical Engineer Pocket Book" for 1901 has been issued by its British publishers, and is now on sale in this country. This is one of the lowest priced pocket books in the market, and it contains a large amount of useful information for reference. Some of the chapters cover: weights and measures, steam boilers and furnaces, steam and the steam engine, oil engines, turbines and windmills, transmission of power by shafts, belts, ropes and gearing, screws and screw threads, crane boots, friction, inertia and strength of materials. There is also a special section on mining machinery. The book is really pocket size and, in leather covers, is sold for 1s. 6d.

Work on the new defender of the America's cup has been commenced in the Herreshoff shops, Bristol, R. I. On the other side of the Atlantic, the order for the competing yacht has been placed on the Clyde by Sir Thomas Lipton, the contestant.

QUERIES AND ANSWERS.

(*Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.*)

Q.—Will you kindly inform me the best internal proportions for a 66-in. by 96-in. Scotch water back marine boiler to burn common wood fuel, and to be allowed 155 lb. steam pressure? I do not refer to thickness or dimensions of material, but in particular to the length of flues, the length of combustion chamber and the width of the water space in the back head. It is proposed to use seventy-six 3-in. tubes and a furnace 30 in. dia. R. M. P.

A.—The dimensions given—boiler 66 in. dia., length 96 in. and furnace 30 in. dia.—are about as good as can be made, although the diameter of the tubes might be reduced to 2 1-2 in. or even 2 1-4 in. and the diameter of the furnace increased as much as possible, with good results. The water space at the back and around the back connection should be 4 in., the back connection about 16 in. in the clear; and the furnace and tubes about 76 in. long. Grate bars for burning wood in such a boiler are not wanted; but only two or three cross bars about 4 or 5 in. from the bottom to admit the air necessary for combustion. The success of such a boiler depends greatly upon proper firing; the wood should be fed often and in small quantities, keeping the fresh fuel well in front and pushing aft as the combustion progresses.

Q.—Will you please answer the following in your query and answer column: If I were sent to some small town to fit out a steamboat and found that the crank pin brasses and crosshead brasses had been stolen, and that there was no machine shop in the neighborhood, how should I proceed to take templets and measurements in order to have a new set made at some distant shop? E. C. P.

A.—If all the other parts of the engine are intact, there will be but little trouble to make sketches and gauges for the boxes.

In the first place, ascertain the stroke of the engine. When the piston rod, crosshead, slippers and guides are in position and cylinder cover on, push the piston to the top of the cylinder as far as it will go, and do the same on the bottom, and mark these two positions on the guides. The distance between these two positions will be equal to the stroke plus the top and bottom clearances. If the measured distance were 37 in. and the stroke 36 in., this would leave 1 in. for clearance or 1-2 in. top and bottom. Then place the crosshead 1-2 in. below the top mark and you will have the right position for the crosshead when the crank is at the top. Then measure the distance between centers of crank pin when in the top position and crosshead pin, and also the distance between the faces of the pins.

If the connecting rod has gib and cotter ends, measure the distance between the butt ends. Deduct the distance between the faces of the pins, and you have the combined thickness of the two brasses between the pins and the butt ends of the rods. You must then use your discretion as to how this must be divided. Suppose the crosshead pin were 4 in. dia., the crank pin 7 in. dia., and you found the distance between centers of connecting rod to be 7 ft. Then the distance between faces of pins would be 6 ft. 6 1-2 in. Then suppose you found the distance between butt ends of connecting rod to be 6 ft. 4 in. Deduct this from 6 ft. 6 1-2 in., which would leave you 2 1-2 in. as the combined thickness of both boxes between the butt ends and the pins. This could be divided as follows: Leave, say, 2 1-2 in. thickness at crank pin and 1 in. thickness at crosshead pin. Then put the straps, gibs and cotters in correct position on the connecting rod, and then you will have the correct relative position of pins in each, and you can sketch boxes to fit the gaps in each. Measure the distance between the crank faces and deduct the usual amount of clearance, and you have the width of the box. Deduct the width of the butt end of rod, and one-half of the remainder gives the width of each flange, or the flange and its circular projection. The amount that the flange overlaps the strap you can judge by experience. It is usually 1 1-2 times the width of the flange. Proceed in the same manner to get widths for the crosshead box. Make a gauge of the diameter of the crosshead pin, and also one of the crank pin. Furthermore, gauges for the widths of the butt ends and between edges of straps are necessary, so that the boxes will fit snugly into the straps.

The method of procedure will be the same for any other style of connecting rod, such as strap, gib and cotter at crank pin end, and the crosshead end forked with two boxes, or if the boxes are of the English type, each with two bolts. It is merely a matter of determining the relative position of the crank pin and crosshead pin to the two ends of the connecting rod, and building boxes to fit the ends and spaces between which they work.

If you wished to have the boxes made before the engine was erected, you would have to know the distance between centers of pins, or what is commonly called the length between the centers of the connecting rod. If you could not get this information, you would have to wait until the cylinders were up and then proceed as described. If a man has had experience in erecting a certain class of engine, it would be possible to get the measurement approximately by calculation and measurement of the parts before assembling, and have the boxes cast and machined to fit the ends and pins, leaving material to spare between the pin and butt end, so that it would be a small job to finish them when the final measurement arrived; or if they were small boxes, the finishing could be done on board by hand.

ENGINEERS' DICTIONARY.—XXXI.

Outboard Delivery Pipe.—The pipe which leads the water from the condenser to the side of the ship, whence it is discharged overboard.

Outboard Delivery Valve.—The valve through which the water is discharged at the outboard end of the delivery pipe. See illustration under EDUCTION VALVE.

Overhung Crank.—A crank in which there is but

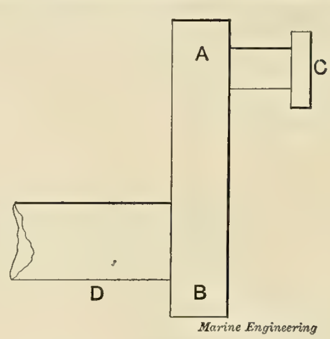


FIG. 90.

one web or crank throw A B, and in which the load carried by the pin A C is supported by one bearing only at or near D. (Fig. 90.)

Overhung Paddlewheel.—The shaft of a paddle steamer is usually provided with an outer bearing on the guards, and an inner bearing on or near the main rail, thus supporting the weight of the wheel between the two bearings. In some cases the outside bearings have been omitted, and in such case the paddle wheels are said to be "overhung."

LOSS OF PASSENGER STEAMER.—A small side wheel steamer, the *City of Monticello*, foundered in the Bay of Fundy, in a gale, on November 10, and more than thirty persons are reported to have been drowned. The vessel plied between St. Johns, Yarmouth and Halifax, N. S., and belonged to the Yarmouth Steamship Co. She was a side wheel iron boat of about 1,000 tons register, built at Wilmington, Del., in 1866. Only one boat got away from the ship safely, and this was dashed to pieces on the shore, only four of the occupants being saved.

TRADE PUBLICATIONS.

A second edition of the lecture by Walter B. Snow on "The Influence of Mechanical Draft Upon the Ultimate Efficiency of Steam Boilers" has just been issued by the B. F. Sturtevant Co., Jamaica Plain, Mass., by whom copies will be sent upon application.

"What Graduates Say" is the title of a four-page folder issued by the American School of Correspondence, Boston, Mass. The text comprises a dozen and a half or more testimonials from engineers and electricians who have been educated in this school by means of correspondence. The letters show that their writers have been benefited by the training and have secured better positions because of the training.

A folder is issued by Patterson, Gottfried & Hunter, 146 Centre street, New York city, describing several of the specialties handled by this firm. As the circular is unfolded a portrait of a salesman opens opposite each page, showing half a dozen different expressions, from extreme mirth to a condition of disgust. Among the specialties illustrated are pumps, engine lathes, screws, boring tools and grinding machines.

Users of blowers will be interested in the catalogue issued by E. P. Reichhelm & Co., 23 John street, N. Y., describing the Reichhelm high pressure blower. The points claimed for this blower are that it delivers a steady and continuous air blast of great volume on a pressure of from one-half to two lbs. and is practically noiseless in operation, and requires small power to operate it. The construction of the blower is fully shown in several illustrations.

Gas furnaces and forges for heating rivets and for other purposes are described and illustrated with much thoroughness in a large and very complete catalogue issued by the American Gas Furnace Company, 23 John street, New York. These forges are made in all sizes and are adapted to all the uses of the ordinary forge. Several of them are especially designed for shipyard uses, such, for instance, as the rivet heater, which is particularly useful where riveting is done by machinery, and where it is advisable to keep the rivets at a uniform heat.

Barrow and Truck catalogue, No. 8, issued by the Syracuse Chilled Plow Co., Syracuse, N. Y., comprises some fifty pages of the specialties of this company. The pages are very fully illustrated. The barrows described and depicted are of both wood and steel, and include the various types that would be used for handling coal, ashes, etc., on board ship and on wharves. A complete line of trucks is also shown, including the various sizes and types that would be used on wharves, in warehouses and on board ship for handling cargoes. The catalogue is very neatly printed.

Users of lubricators will want to send for the useful little catalogue issued by the National Lubricator Co., 258 North Pearl street, Albany, N. Y. The construction and operation of this lubricator is fully described in this catalogue. Unusual economy is claimed, as the flow can be readily regulated, and the device works only when the machinery is in operation, and then in proportion to the speed. It can be used on main engines, steam pumps and in any other position where lubrication is desired. The several forms of lubricators are illustrated in the catalogue, copies of which can be had upon application.

Fine tools manufactured by the L. S. Starrett Co., Athol, Mass., have a very complete catalogue devoted to them, which has just been issued as catalogue No. 16. It comprises over one hundred pages, and is very neatly printed, each tool being illustrated and described as completely as is necessary. An index adds much to the completeness of the catalogue. All kinds of fine tools are shown, such as bevels, calipers, nippers, gauges of many kinds, micrometers, rules, squares, etc. Several of the tools have been made and designed since the previous catalogue was issued, and have been added to this catalogue. A special feature is that rules and gauges having graduations may be had in the metric as well as standard measure. The catalogue is one that every engineer and mechanical man will want to have for reference.

Ship builders, boiler makers and tank builders have a catalogue published in their interests by the Smooth-On Mfg. Co., 547 Communipaw avenue, Jersey City, N. J. The pamphlet comprises eight pages and cover, and gives a full description of this compound. As described, it is an iron compound, prepared in power form and applied by mixing with water to the consistency of a very stiff putty. It hardens in a few hours. When it hardens it is the color of iron, and it can be used on all permanent joints, main stay-braces, screw stay-nuts, and in all repairs, such as applying temporary patches. It is always ready for use, is easy mixed and when protected from dampness will retain its strength. The special feature claimed for Smooth-On is that it expands and contracts the same as iron, thus making it valuable for stopping a hole in a steam or water pipe or for stopping leaky screw thread joints. Copies of the catalogue and other information can be had from the manufacturer.

"The Marine Engineers' Year Book" is a volume 6 by 9 in. in size issued by the Consolidated Marine Engineers' Beneficial Association, No. 33, with headquarters at Marine Engineers' Hall, 283 Hudson street, New York. The volume is bound in board, with cloth, and comprises more than 250 pages. There is much matter which will interest every engineer, the reading matter being of an educational nature. Much attention is given to the boiler room, not only in describing boilers themselves, but explaining the method of testing boilers, together with articles regarding valves, feed-water evaporators and many other similar subjects. In the same way the steam engine and engine room are described, and several pages are devoted to indicator cards and horse power. Propellers and thrust bearings have several pages devoted to them. Many pages are devoted to electricity and its uses as concerns marine work. The Marine Engineers' Association as an association is referred to, and the local association has a history of it given and a directory of its members. Altogether the book is most creditable to the association. Every member in good standing is entitled to a copy of this book without charge. Extra copies may be obtained from Henry B. Lister at the association headquarters for $2. The book was published under the supervision of Mr. Lister, who spent many years at sea, but who is now practicing law at No. 71 Broadway, N. Y.

BUSINESS NOTES.

LORD'S BOILER COMPOUND.—Owing to the increase in his business, George W. Lord has been compelled to move into much larger quarters than those formerly occupied by him on Union street, Philadelphia, and has taken a building three stories high at 2238 to 2250 on North Ninth street. With his new facilities Mr. Lord is prepared to supply orders of any size from this time on.

A COMPLETE YACHT SUPPLY STORE.—Charles D. Durkee & Co. have erected a very complete building, six stories high, with cellar, at 2 and 3 South street, New York, where they open the new year with a complete line of yachting supplies of all kinds and many ship chandlery goods. The building has a width of 40 ft. and is 110 ft. deep, making the store probably the most ample one in the line in the country. The cellar will be used for anchors, cordage and such heavy goods, and the first and second floors will be devoted to supplies of all kinds. To give some idea of the completeness of the arrangements for doing business promptly and for carrying supplies of every kind, it is interesting to note that on the left-hand side of the store there have been built 2,300 boxes and drawers, varying in size from 2 by 4 in. to 12 in. square. The offices will be in this department. The top floor has been made into a sail loft, and gives ample proportions for this work. The floor immediately underneath will be the rigging loft, which will be in charge of John F. Byno, who has been known so many years in New York in the rigging business. It is the intention of the firm to carry in stock everything that can be asked for in the line of yacht and boat hardware and fittings, and contracts will be made to take complete charge of furnishing everything for yachts and boats.

OPENING FOR MARINE REPAIR WORK.—The Brooklyn Wharf & Warehouse Co., 68 Broad street, New York, offers special facilities for establishing a dry dock, repair shop or shipbuilding plant in New York Harbor.

NEW AIR COMPRESSOR COMPANY.—The New York Air Compressor Co. was recently organized with a capital stock of $100,000, with headquarters at 120 Liberty street, New York. The company has secured a complete plant and machine shops at Arlington, N. J., which are being thoroughly equipped with all the tools necessary to build air-compressing machinery of all kinds. The president of the company is J. W. Duntley, well known in connection with the Chicago Pneumatic Tool Co., and the secretary and treasurer is W. P. Pressinger, who has been connected with the trade for many years in New York.

BULLOCK ELECTRIC APPARATUS.—When the Bullock Electric Mfg. Co. moved into its new plant in the suburbs of Cincinnati, O., a year or so ago, it supposed that it had ample space for a long time to come. So great has been the increase of business, however, that it has been compelled to extend the main building 200 ft. The addition will make the main machine shop 500 ft. long by 101 ft. wide. The best month's business in the history of the company has just closed. Fifty-one machines were sold, several of them being repeat orders, and coming not only from all parts of the United States, but from several foreign countries.

BALL-BEARING SHEAVE WHEELS.—The increased prosperity in all lines of business is strongly felt by the Pennsylvania Block Co., 2049 North Second street, Philadelphia, Pa. This company recently moved into much larger quarters, but has already found it necessary to put in considerable new machinery to meet the increased demand for the Parkin Ball-Bearing Sheave Wheels. The amount of business is reported as double what it was two or three months ago. These wheels have already proved their quality for ship and yacht work, and larger sizes have been made apparently with equal results. One of the recent and most interesting orders comes from three large steel mills for bushings to be used on 6 in. and 8 in. shafts with four rows of 4 in. high test steel balls. The company also has orders to prepare full equipments for two shipyards as soon as the goods can be manufactured.

UPHOLSTERY AND NAPERY SUPPLIES.—The business of M. W. Fogg has so outgrown the present quarters, at 18 Fulton street and 195 Front street, New York, that much larger quarters have been taken at 20 Fulton street, corner of Front street, and by February 1 the business will be moved into these new quarters. In this connection it is interesting to note that this business of supplying everything in the line of cushions, bedding and upholstery for steamships and yachts has been within 300 ft. of this corner for fifty-eight years. The business has grown so that it now covers everything in the line of mattresses, pillows, pillow covers, sheets, blankets and everything in the line of complete berth fittings, cushions of all kinds, carpets, rugs, curtains, towels, deck chairs and all other such furnishings. Mr. Fogg has orders on hand for complete furnishings in his line for several coastwise steamers and a number of yachts.

A Book for Engineers.—A handy vest-pocket reference book containing, in addition to much valuable information, several hundred questions on engineering, and is sent to all engineers by the American Injector Co., Detroit, Mich., by mentioning Marine Engineering.

Feed Water Filter.—The Ross Valve Co., Troy, N. Y., reports numerous letters from users of its feed water filter, which is used on many of the transatlantic lines. Many engineers report making long trips, consuming a month or more, without the necessity of changing the filtering cloth, merely washing it by reversing the flow. Pamphlets regarding these are sent to all who are interested. One of the claims made for the filter is that it takes all the sediment out of the feed water.

Busy Tool Makers.—Charles H. Besly & Co., 10 and 12 North Canal street, Chicago, Ill., report their December business as unusually brisk. At their factory, Beloit, Wis., they have just added new boilers and engines supplementary to water power, and are working sixteen hours four days a week, the balance ten hours per day. They are receiving numerous orders for their helmet bronze in sheet for flat springs and in wire for round springs. They carry an immense stock of this material in stock at their Chicago store, and, therefore, are prepared to make immediate shipments. Owing to the many advances in raw material there have been a number of changes in prices in standard machinists' tools and supplies, and Besly & Co. suggest that orders be placed at once.

A Busy Year.—The B. F. Sturtevant Co., Boston, Mass., reports an increase of nearly 40 per cent in the volume of its business for 1899 over that of the previous year. The shipments, both foreign and domestic, included fan blowers for all purposes, heating, ventilating, drying and mechanical draft apparatus, engines, electrical apparatus, etc. During the past year an addition covering 20,000 square ft. has been made for the use of the electrical department, which has shown the most rapid growth, the output having more than doubled during the year, and covering principally electric fans and special generating sets. The sale of mechanical draft apparatus has been practically quadrupled, while the output of engines has increased one-third over that of the preceding year, and has included many special designs.

The Fore River Engine Works.—The Boston *Globe* of November 30 had a very interesting illustrated article regarding the Fore River Engine Works, Weymouth, Mass. A history of the company is given, beginning back fifteen years ago, when it built marine engines in a very small way. Under the management of F. O. Wellington the plant has been steadily increasing in size, until now 350 men are employed. The company owns sixty-eight acres or so of land and a large amount of water front convenient to Quincy Bay, adjacent to Boston Harbor. This company has made a great reputation among yachtsmen for its engines and hulls, and during the past year has established a large plant for building steel hulls. In addition to a large amount of yachting work, the company has on hand two torpedo boat destroyers, an order for a light ship and for the cruiser *Des Moines*. A large addition 300 ft. long will be made to the plant at once.

Pneumatic Hammers.—The Q. & C. Co., Western Union Building, Chicago, and 106 Liberty street, New York, calls special attention to its pneumatic hammer, which is valveless, and which has many features quite different from the ordinary hammer. These hammers are by no means new on the market, having been in use for some time, and having already established their efficiency and good qualities.

The Row Tube.—A patented tube which will interest engineers very much is just being put on the market by the Heat Transmission Co., Danbury, Ct. It consists of an ordinary circular tube which is indented in a regular manner, the identation having a curved section. The purpose of this is to break up the water coming in contact with the tube and preventing scale from forming as rapidly as in other tubes. The claim is made that because of the indentations the efficiency of the tube is doubled and that it becomes more elastic. The tube is adapted for feed water heaters, evaporators, and any use involving the abstraction of heat by means of tube surface.

Williams' Submarine Compositions.—In a letter to the manufacturers of this composition the recent manager of the Brooklyn and New York Ferry Company said: "We take pleasure in saying that you have coated our seven iron ferry boats with your submarine protective and anti-fouling compositions, and that we are well satisfied." This composition is manufactured by M. J. Williams, 77 South street, New York.

PARAGON BOILERS.—There has been a large demand lately for Paragon Boilers, invented and sold by Capt. M. DePuy, 19 South street, New York. These boilers have proved satisfactory for use on river boats and other small boats.

USEFUL PIPE CUTTER.—Those of our readers who have occasion to use a pipe cutter will be interested in an advertisement published elsewhere by the Barnes Tool Company, New Haven, Conn. This tool is made in all sizes and to suit all conditions.

A STEEL EXPOSITION BUILDING.—The Berlin Iron Bridge Co., East Berlin, Ct., shipped recently twenty-seven carloads of structural metal, which is the skeleton of the machine shop to be used by American exhibitors at the Paris Exposition. The building will be 343 by 77 ft., and was shipped all parts complete, ready to be erected without delay.

BUFFALO FEED WATER HEATERS.—The Buffalo Feed Water Heaters and Purifiers are in use on many of the large modern steamers on the Great Lakes, with all types of boilers, square, marine, Scotch, cylindrical, and water tube, and with steam pressures from 40 to 250 pounds. In every case they are reported to have given good satisfaction, and in many instances orders have been duplicated. No skilled help is required to operate them; they are not liable to get out of order. That they increase the life of a boiler and decrease the cost of repairs is a special claim of the manufacturer, Robert Learneveth, 200 Lafayette avenue, Buffalo, N. Y.

SUPERIOR GAS ENGINES.—In writing to the Lake Shore Engine Works, Marquette, Mich., regarding a Superior gas engine recently purchased, Peter Anderson, of Marquette, says: "The 8 H.P. double cylinder Superior gasoline engine installed in our fish boat this spring as auxiliary power gives us perfect satisfaction. We have no use for sail power since installing the engine. We make a trip every day of 10 to 12 hours' run, and have never had the first trouble with our engine. The boat is 41 ft. long by 10 ft. beam, and makes seven miles an hour. We now use twice as many nets as heretofore, and make six trips a week, instead of two or three before."

A LARGE PROPELLER.—H. G. Trout, Buffalo, N. Y., shipped the latter part of November a solid cast iron propeller 14 ft. in diameter from his works in Buffalo to go to Mobile, Ala., by way of New York city, for the steamer *S'Oteri*. The weight of the propeller was 7,500 lb. It is stated that there has only been one other propeller as large as this cast solid in a lake port, and this one was furnished by Mr. Trout last season for the ocean going steamer *Pensacola*. This season is reported as being one of the best in the history of this company, and there is an especially large demand for propeller wheels for ocean going freight steamers as well as for vessels on the Lakes.

COMBINATION PACKING.—A new packing has been put on the market by A. W. Chesterton & Company, 49 India street, Boston, Mass., which is an elastic sectional rod and plunger packing. It is intended to be one of the best steam packings in the market, and is especially good for hydraulic work, or where the packing comes in contact with cold water. The packing is so made that the rubber cushion expands in heat and keeps the stuffing box tighter, while it acts as an elastic cushion when used as hydraulic packing. The flax acts as a reservoir for oil and lubricates the rod. Being sectional, but little pressure on the gland is necessary, and on account of the give and elasticity the packing can be almost entirely used up.

MANY NEW AIR COMPRESSOR PLANTS.—The Clayton Air Compressor Works, 26 Cortlandt street, New York, report their factories as crowded with orders, both domestic and export. Among the plants which have recently been equipped with Clayton machines are the following: Pacific Coast Borax Co., of Bayonne, N. J.; McIntosh, Seymour & Co., Engine Builders, Auburn, N. Y.; The Frick Company, Waynesboro, Pa.; Standard Oil Company, Long Island City; New York & Boston Dyewood Co., Greenpoint; Lelance & Grosjean Mfg. Co., Agate Manufacturers, Woodhaven, N. Y. The Clayton Co. is now filling a large order for compressors to be used by the Russian Government, and also building three-stage compound compressors for the Platt Laboratory, Atlanta, Ga.; Sault Ste. Marie Pulp & Paper Co., Saulte Ste. Marie, Ont.; Geyser's Natural Carbonic Acid Gas Co., Saratoga Springs; Compressed Gas Capsule Co., Bridgeport, Conn.

New Form of Exhaust Head.—One of the important features of a modern steam plant is an exhaust steam pipe head. To be effective it must thoroughly separate the water from the steam, and thereby prevent the constant spraying of roofs and walls with consequent deterioration and expensive repairs. In the form of exhaust head built by the B. F. Sturtevant Co., Boston, Mass., the principle of centrifugal force is utilized to secure perfect separation. Dry exhaust steam weighs only .038 lb. per cubic foot, while water of the same temperature weighs 59.36 lb. per cu. ft. It is, therefore, evident that inasmuch as centrifugal force is proportional to the weights of the bodies in motion, the water will be thrown outward with much more than the force exerted upon the steam. In the Sturtevant exhaust head the steam passes up the interior pipes, is discharged tangentially close to the shell, and is thereby given a vigorous whirling motion. The entrained water—likewise the oil—flies outward, strikes the cool side and trickles down to the outlet at the bottom. The steam, now perfectly dry, finds ready escape through the central opening above. The action is positive and absolute. Perfect separation must be the result. These heads are built in sizes to fit pipes from 1 in. to 20 in. All sizes above 10 in. are flanged instead of tapped.

Correspondence Instruction.—The United Correspondence Schools of New York city have a course of study in Marine Engineering. The system of practical education by mail has been developed to a high point by this institution. Unlike the pupils of an ordinary college, they do not have to reside in any one locality. They do their studying in leisure hours, so as not to interfere with their daily work, and they do not have to give up the salaries or wages which mean a living to them. There never was a time when such a demand existed for competent engineers as at present. Hundreds and thousands of bright, intelligent men are now working from morning until night at low wages who would be good engineers if they only had been able to pursue the necessary studies; but circumstances have prevented them from taking a course in technical education at a college. All who wish to fit themselves for work of this kind by studying in their leisure hours, without interfering with their daily work, can write to the United Correspondence Schools Company, 154-156-158 Fifth avenue, New York city, and ask for particulars. The cost of tuition is moderate, and a system of small monthly payments makes it easy for any one to take up the study. The instructors are experts, who have been through the practical work themselves, and who are fitted to be of direct assistance to every student, and to understand the particular needs of each.

A Busy Shipyard.—The S. S. *San Juan*, which was recently launched for the New York & Porto Rico S. S. Co., of New York, at the Harlan & Hollingsworth Yard, Wilmington, Del., is a sister ship to the *Ponce*. She is designed to carry the maximum amount of freight on the smallest coal capacity, and is of the following dimensions: Length over all, 335 ft.; length on water line, 322 ft.; beam moulded, 42 ft.; depth at center to main deck, 19 ft. 10 in.; depth to spar deck, 27 ft. 8 in.; draft loaded, 19 ft.; gross tonnage, 3 503. Her engines are direct tri-compound, with inverted cylinders 24 in., 38 in., 62 in. and 42 in. stroke. Steam is supplied by two Scotch boilers 14 ft. 6 in. dia., 11 ft. long, with six furnaces 48 in. dia. and built to stand a working pressure of 180 lb. She has six water-tight bulkheads, four hatches, four winches, Hyde steam capstan, two steel masts, electric light plant for 250 lights, five-ton evaporator, five tanks of 8,000 gallons capacity, bunker capacity 350 tons. Accommodations for seventy-two first class and twenty second class passengers are provided, and she is built to sustain a sea speed of 12 knots. She is tastefully fitted out with hardwood, and has every modern convenience. The *San Juan* is the eighth ship launched by the Harlan & Hollingsworth Co. in the past year, and there are now in the yards the torpedo boat destroyer *Stringham*, two 29-knot torpedo boat destroyers for the United States Navy, the *Hull* and *Hopkins*. Two freight steamers for the New York & Baltimore Transportation Line are now in frame

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

DRAUGHTSMAN WANTED.

A young man is wanted in the draughting room on marine work. Address, DRAUGHTSMAN, care Marine Engineering, 309 Broadway, New York.

YACHT ENGINE WANTED.

New or second-hand compound yacht engine wanted, about 100 h. p. Send full description and lowest price to PIGOTT & FRENCH CO., Seattle, Wash.

SECOND-HAND ENGINES WANTED.

WANTED—One second-hand Compound Condensing Fore and Aft Steamboat Engine, cylinders 14 x 28 x 14, or one second hand Double Steeple Compound Condensing Engine, cylinders 9 x 18 x 24, or approximating these sizes; also one Double Simple Engine, cylinders about 7 x 9. Address

A. C. WADE, Jamestown, N. Y.

TO SHIPBUILDERS AND ENGINEERS.

A position of responsibility, in charge of construction or steam engineering design, is desired by an engineer of wide experience on the Clyde and in American yards. Responsible for machinery design and construction of recent highly successful vessels. Much experience in drawing up estimates and in closing contracts. Can produce results in the draughting room, the shop, or on trials. Address, RESULTS, care Marine Engineering, 309 Broadway, New York.

THE WATSON WATER TUBE BOILER.—Egbert P. Watson, Elizabeth, N. J., the inventor and manufacturer of the Watson water tube boiler, calls attention to the fact that his boiler conforms to the desirable qualities in a marine water tube boiler recently referred to by Engineer-in-Chief George W. Melville of the Navy, in his address before the Society of Naval Architects.

PNEUMATIC TOOL PATENTS.—The litigation which has been going on for some time over pneumatic tool patents has been adjusted, so far as the Standard Pneumatic Tool Co. and the Chicago Pneumatic Tool Co., both of Chicago, are concerned. Each company has made arrangements to use the other's patents under conditions mutually agreed upon, thus protecting each other's customers and removing all threats of infringement claims.

ELECTRIC HEATERS.—Yachtsmen and others who operate vessels on which there are electric plants will be interested in the improved electric heaters manufactured by the Gold Car Heating Co., Frankfort and Cliff streets, New York. These heaters have many features peculiar to themselves, and have been used quite extensively on electric cars and in other places where compactness and efficiency are desired.

HOLLOW STAYBOLTS.—The Falls Hollow Staybolt Co., Cuyahoga Falls, O., emphasizes the fact that its hollow staybolts are rolled hollow from solid material, thus giving uniform strength throughout, so that the fire box which is equipped with these bolts will stand every wear and tear. The claim is made that the drilling process adopted for other bolts weakens the bolt and causes it to break more quickly.

THE PLAINT OF THE STOKER.

Ay! sing the admiral's praises,
An' sing o' the captain, too;
An' swill yer wine to the staff an' line
An' all o' the gun-deck crew,
But who's to sing o' the stoker,
Er tell o' the part he bears?
Fer he lives in a hole, an' he dies in a hole,
An' who the devil cares?

So strip to the waist, my maties,
An' work as a stoker works,
Fer fast er slow, the man below
Is never the man who shirks;
An' the first to drop, we'll lay him
Soft side o' the fireroom stairs,
Fer he lived in a hole, an' he dies in a hole,
An' who the devil cares?

There's a chase in sight, my maties,
An' "Steam! more steam!" 's the cry;
So bend your backs to the grating racks,
An' work 'till it's time to die;
Fer the ship must do her duty
In pride o' the flag she wears
Tho' we live in a hole, an' we die in a hole,
An' who the devil cares?

Come! strike up a song, my maties,
An' mock at the death-white heat;
Fer the fight's begun, an', lost or won,
The heart o' the ship must beat!
Fer them at the guns there's glory
That never a stoker shares—
Fer we live in a hole, an' we die in a hole,
An' who the devil cares?

So on with the dance, my maties,
Tho' you sob an' gasp fer breath;
For the demon Coal is black o' soul,
An' he drives his slaves to death!
But we'll sink or swim together,
An' it's little we'll get o' prayers—
Fer we live in a hole, an' we die in a hole,
An' who the devil cares?

—*Karl Kennett in Kansas City Star.*

PNEUMATIC RIVETERS.—The pneumatic riveter manufactured by the Bethlehem Foundry & Machine Co., South Bethlehem, Pa., has been introduced in many shipyards and boiler shops, and is found to be exceptionally efficient. The claim is made that two men and two boys operating one of these riveters can drive as many rivets in one hour as two men and one holder-on can drive by hand work in a day of ten hours. The use of skilled labor is done away with by these machines.

TONKIN BOILERS.—The demand for his patented internally fired water tube boilers was such that John J. Tonkin, whose headquarters are at 26 Cortlandt street, New York, was compelled last summer to build a new factory. This plant is now practically completed, and Mr. Tonkin is ready to fill all orders more promptly than ever before. The features claimed for the boiler are the rapid circulation and great economy of the boiler, that can be used up to 500 lbs. pressure if need be.

A THRIVING PUMP BUSINESS.—The Union Steam Pump Co., Battle Creek, Mich., has been so crowded with orders for some months past that it has been compelled to largely increase the capacity of its plant, and the main building is having a second story added to it. The rush of work was such that the shop could not be shut down, so the second story was built without interfering with the ordinary routine of work. This building is now nearly completed, and the company will immediately equip it with machinery in order to be able to keep up with the orders.

TRADE PUBLICATIONS.

"Force Feed Lubrication" is the title of a neatly printed catalogue, 4 by 6 in. in size, issued by the Stirling Lubricator Company, Rochester, N. Y. The catalogue is exceptionally well printed and comprises 16 pages, and describes concisely the Stirling force feed lubricator. Two excellent pictures of the lubricator are also given. The special features of the lubricator are strongly emphasized.

Machinery Advertising is the name of a publication which has just made its appearance in Cleveland, Ohio. The heading states that it is a journal of advertising, suggestion, advertising information, advertising media for machinery and supply makers of boilers. It is the convenient size of 6 by 9 in., well printed, and the first number, just at hand, would indicate that this new publication has a field for itself.

The Mianus Motor Works, Mianus, Ct., issues a very attractive catalogue, 4 by 7 in. in size, and thirty pages or more, illustrating and describing their gas engines. Several pictures of the engine are given and much detailed description. Much attention is given to the sparking device. This company also manufactures hulls, and several pictures are given of the types. Yachtsmen and others interested in gas engines will want to send for a copy of the catalogue.

The Durable Wire Rope Company, 234 State street, Boston, Mass., issues a catalogue, 4 by 6 in. in size, describing the wire rope it is putting on the market. This rope is a recent invention, and its many characteristics are fully described in the catalogue. Several half tone engravings show the construction of the rope and the manner in which it is protected. This rope is designed especially for running rigging, hawsers, and all uses where rope is needed in marine work. One of the special claims made for the rope is that it will not rust.

Yachtsmen and others will be interested in a very handsomely printed catalogue entitled "Boats and Their Construction," issued by the Taunton Yacht Works, 1202 Harrison Building, Philadelphia, Pa. The catalogue is well illustrated and the text is divided up under the heads of steam yachts, sailing yachts, launches, house boats, yachts, boats, skiffs and canoes. As stated in the text, the purpose of this company is to adapt all boats to the requirements of the owner. Special attention is given to steam yachts, house boats and the better grade of launches.

Users of pipe coils and bends of every description for heating and cooling will be interested in a catalogue on this subject issued by the Whitlock Coil Pipe Company, Elmwood, Ct. It refers to iron, brass, and copper pipes or tube. A number of illustrations are given, showing coils of various kinds, such as oblong, zig-zag, spiral, conical, flat and irregular, quarter turns, and return bends. Other catalogues are issued by this company, one devoted to feed water heaters, in which the American Standard feed water heater is illustrated, and the other on feed water and special heaters, purifiers, etc.

Gas engines manufactured by Palmer Bros., Mianus, Ct., have a well illustrated and interesting catalogue devoted to them, 5 by 7 in. in size. Several types of the engines are depicted and many launches are shown equipped with these engines. Altogether there is much information in the catalogue which would be of use to yachtsmen and other users of engines. Many testimonials are given from purchasers, speaking in high terms of the efficiency of the engine. A second catalogue is issued showing the manner in which the Palmer engine is worked for automobile uses. Reference is also made to several accessories for yachtsmen, such as acetylene searchlights, etc.

Users of marine hardware, as well as rigging, cotton duck, engineers' supplies, and in short everything that can be called for on vessels or yachts, should have a copy of catalogue No. 25, issued by George B. Carpenter & Co., 206 South Water street, Chicago, Ill. The catalogue is 7 by 10 in. in size, and is very fully illustrated. A good deal of attention is given in the front of the book to yachts of all kinds. Following this are many pictures and tables of size of screws, nails, capstans and everything that goes to complete launches and yachts. Some interesting lessons in tying knots, etc., are given. Binnacles, compasses, lamps, and lanterns and all kinds of life-saving apparatus receive full attention. Much completeness is added to the catalogue by an index which in itself comprises about eight pages.

The Row tube for boilers, condensers, heaters and such uses, although a new product in this country, is not new across the water, having been in use there for some years. It is described in much detail and in its many applications in a complete, neatly printed, well illustrated catalogue issued by the manufacturers of it, the Heat Transmission Company, Danbury, Ct. Illustrations are given of the manner in which the tube is indented, thus increasing its heating capacity, as claimed in the catalogue, twofold. This indentation makes the tube more elastic lengthwise. Another claim is that the liability of fracture or leakage is greatly reduced. Illustrations in the catalogue show the tube as applied to feed water heaters, evaporators and fresh water condensers, radiators, etc. These tubes have been used extensively in boilers, and among the recently equipped yachts is Sir Thomas Lipton's *Erin*.

Four interesting catalogues for shipbuilders and marine engineers are issued by the Buffalo Forge Company, Buffalo, N. Y. One is devoted to the various types of engines manufactured. These are for running direct connected electric plants, but not for purposes of propulsion. The engines are very handsomely illustrated and completely described. Another catalogue is devoted to mechanical induced draft. Several types of draft fans are shown, and each is completely described. Another catalogue takes up the question of mechanical forced draft, and fans of the different types are illustrated and the system of draft shown by illustration. The other catalogue is devoted to forges and the down draft type by which smoke is removed as generated. A number of types of forges are illustrated, and their construction is made quite apparent by the handsome quality of the illustrations. These catalogues are about 4 by 7 in. in size, and undoubtedly copies of them will be sent to all our readers who wish.

A very handsome book has been issued by the Babcock & Wilcox Company, 29 Cortlandt street, New York, regarding their marine type water tube boilers. The book comprises 118 pages and is handsomely printed on heavy half-tone paper and is firmly bound in board. As the pages are 9 by 11 in. in size, good opportunity is given for illustrating the boilers. The text is very complete, covering very fully the history of these boilers and describing many of the vessels upon which the boilers have been placed. The reputation made by the Babcock & Wilcox boilers is evident from the fact that over 50,000 horse power is under construction in the Elizabeth shops at this time. Every part of the boiler is fully illustrated in this book, and all the types of vessels upon which the boilers have been installed are shown. A great deal of important information is given regarding the installation and management of boilers. There is also much information regarding the subject of testing water. The subject of corrosion is gone into fully. A very complete index adds to the value of the book.

The 1900 catalogue of steam steel yachts, launches and all kinds of engines, etc., manufactured by the Racine (Wis.) Boat Mfg. Co. is more complete than the previous ones issued by this company. The catalogue comprises over seventy pages, 6 by 10 in. in size, and the printing is very effectively done in two colors. The establishment of this company is well illustrated, showing how thoroughly the facilities are for all kinds of yacht work. Several large steam

yachts which the company has built are shown and fully described, and there is much information regarding the water tube boilers and engines which the company manufactures. The subject of launches is very fully covered, and many illustrations are given of the various styles and types of launches manufactured. Many pages have five illustrations on a page, and a number of dimensions accompany them. Much more information is given regarding the various styles of launches than usual. Altogether the catalogue is an unusual one. Sloops, schooners, and cat boats have several pages devoted to them, and in the back part of the catalogue canoes, hunting boats, and boat fittings receive considerable attention.

The Chapman Valve Mfg. Co., Indian Orchard, Mass., has issued one of the most business-like and useful catalogues we have ever received from a manufacturing establishment. It is a cloth-bound volume of 400 pages, size 5 by 8½ in., devoted exclusively to valves, fire-hydrants and their accessories, such as flanges, floor-stands, gearing, indicators, etc. It includes descriptions, illustrations, price-lists and dimension sheets of solid wedge double-face gate valves for every purpose and pressure of all sizes from ¼ in. upward. Valves for different services and pressures are designated by list numbers, thus affording a ready means of identifying any particular kind of valve. The book is divided into twelve "sections," as follows: (1) Bronze valves of all kinds; (2) iron body valves with babbitt seats for water of any pressure and for steam of any temperature not exceeding 325° Fah.; (3) iron body valves with bronze seats for steam of high pressure or temperature; (4) iron and semi-steel valves for gas, oil and ammonia; (5) companion flanges and flange unions; (6) indicators, floor-stands and gearing for the preceding valves; (7) fire-hydrants of all kinds; (8) sluice-gates; (9) instructions for ordering; (10) dimensions of gate valves; (11) recommendations to purchasers; (12) Chapman globe valves. In the first four of these sections the various kinds of valves are described and illustrated, a complete description accompanying each list. A new and specially valuable feature of these descriptions is that in each is mentioned a number of purposes for which the valve is particularly adapted and the allowable working pressure of the valve is given. The working pressures covered by these lines of valves range from vacuum to 6,000 pounds per square inch. Sections 10 and 11 are of special interest to engineers and designers. The first contains complete dimension sheets of all the valves, flanges, etc., covered by the 61 preceding lists. The second contains the makers' detailed recommendations concerning the proper kind of valve to be used for each of the various pipe lines of a number of the more common installations. Section 12 is devoted to an exposition of a new and improved type of globe valve, which this company is now getting out, and a complete alphabetical index ends the book. The book is well printed and splendidly illustrated, and has apparently been prepared by an engineer who has a thorough understanding of the needs of designers and power users.

BUSINESS NOTES.

Cross Oil Filters.—The business of the Burt Manufacturing Company, Akron, Ohio, has been increased so greatly of late, and many large orders have been filled for Cross oil filters. Thomas A. Edison has just placed a large duplicate order for these filters, and the Metropolitan Electric Supply Company, one of the largest electrical concerns in the British Empire, has recently placed an order for four 90-gallon Cross filters. The British Government has also been a large buyer of these filters during the past year.

The Ellis System of Plumbing.—A new system of marine plumbing is being introduced by the Ellis Marine Plumbing Company, 32 Broadway, New York. The system has already been tested, having been installed on the steam yacht *Neaira* of Mr. Charles Gould. The feature of this system is the drainage tank, which is placed low down in the vessel. This tank is so constructed as to automatically empty and close itself, and is provided with ample ventilation, thus avoiding the obnoxious odors frequently encountered where the plumbing is antiquated. The tank discharges automatically at any given point and can be operated by steam, water, or air. In steam yachts the connections are usually made with the steam plant, but in sailing yachts, the system can be operated by hand pump which uses either air or water. The closest fixtures are of the usual type. The system is arranged and ventilated according to the requirements of the sanitary laws of the City of New York. An important point is that the skin of the vessel is pierced at one point only for the discharge pipe from all the fixtures in the ship. The company guarantees it to work for one year and offers to inspect any vessel and make recommendations regarding sanitary appliances.

"Little Giant" Pneumatic Tools.—Mr. H. J. Kimman, managing superintendent of the Standard Pneumatic Tool Company, Marquette Building, Chicago, Ill., has just returned from an extensive business trip to the large European centers. While in England he supervised the establishing of large works at Chippenham, near London, for the manufacture of "Little Giant" pneumatic tools for European trade. Over $50,000 worth of the most improved machinery and labor-saving devices were installed in this plant. Mr. Kimman reports that the opposition of the labor organizations across the Atlantic to pneumatic tools, because of their labor saving qualities, is greatly dying out. The export business of the Standard Company has been very great during the past year, and "Little Giant" pneumatic drills, hammers and boring machines are being adopted by some of the largest ship yards, machine shops and boiler works, not only throughout the British Isles, but throughout all parts of the Continent. One of the most recent orders of the Standard Company was for $25,000 worth of tools to go to Holland. The domestic trade has even more than kept pace with the export, so that the Standard Pneumatic Tool Company will probably again be compelled to increase the capacity of its works.

CALENDARS RECEIVED.

David Kahnweiler Sons, 437 Pearl street. New York. The calendar contains a reproduction of the famous sea picture, "To the Rescue."

The Standard Varnish Works, 29 Broadway, New York. A very effective calendar in appearance, 12 by 19 in. in size. A colonial dame is very well represented in colors.

The Youngstown Iron & Steel Roofing Company, Youngstown, Ohio. At the top of the calendar is a color picture in a gilt frame, "The Bride and the Fortune Teller."

The Bullock Electric Mfg. Co., Cincinnati, Ohio, calendar for the month. The January issue is very artistic, and is printed in several colors, and has a Happy New Year greeting.

The Johnson Iron Works, New Orleans, La. A calendar about 3 by 6 in. in size with a sheet for each month. The calendar is printed in several colors and at the head is a picture entitled "Joy."

Thomas P. Benton & Sons, La Crosse, Wis. A large calendar printed in red. At the top is an effective picture, "Under the Willows." It represents a meadow scene with cattle resting under a group of willows.

The Western Electric Company, Chicago and New York. At the top is a picture of a wharf scene, and in the distance is a large building, which is the New York factory of this company. At the dock in the foreground an ocean liner is loading with grain.

M. W. Fogg, 20 Fulton street, New York. At the top of the calendar is a scene in water color of three sloops in full sail. The tides at Governor's Island, New York, are given for each day, and an explanation by which the tides at Sandy Hook can also be estimated.

The Ashton Valve Company, 271 Franklin street, Boston, Mass. A lithographed calendar with picture, 5 by 7 in. in size, of the "Summer Girl," with a sheet attached to the calendar for each month in the year. A copy of this calendar is sent to engineers or others interested in marine work who mention MARINE ENGINEERING; to outsiders a nominal charge of ten cents is made.

The American Steam Gauge Company, Boston, Mass. A neatly lithographed calendar, 8 by 10 in. in size, the entire calendar being on one piece of bristol board, is sent out by this company. The steam pump is effectively lithographed on one side, and nearly opposite is a picture of the works of the company.

The Bethlehem Steel Company, 100 Broadway, New York. A very effective calendar, 12 by 18 in. in size, is issued by this company. At the top is an engraving of the hydraulic forge working up a hollow shaft from an ingot of fluid compressed steel. On each of the monthly sheets is a different picture representing the different scenes in the forging department.

Wilson & Silsby, Rowe's Wharf, Boston, Mass., issues an especially nautical calendar, at the head of which is an excellent picture of the schooner yacht *Latona*. In addition to the days of the month, the calendar gives the local time for high water, low water and when the sun rises and sets. The table gives the record for the Boston Navy Yard, but by means of a key accompanying the calendar it is easy to find out the tides in most of the New England ports, as well as in New York and elsewhere.

Copies of these calendars can probably be had by writing to the publishers and mentioning MARINE ENGINEERING.

A Long Established Boat Business.—The boat business of John T. Smith, 159 South street, New York, is now so extended that it includes the manufacture of a complete line of life-saving boats, also launches and yachts.

Asphalt Roofing and Paint.—Users of asphalt for roofing purposes, asphalt paint, roofing cement and kindred specialties will be interested in the business conducted by the Asphalt Ready Roofing Company, 136 Water street, New York. The roofing is especially designed for use of wharf buildings, boiler houses and similar uses. It is not effected by salt atmosphere, as much metallic roofing is, and the manner of laying the roofing is very simple. No paint for protection is necessary. This roofing is claimed to be proof against fire, and has proved very desirable where there is danger of leaks. The asphalt paints which this company sells are put up in convenient packages, and are particularly designed for protecting metal surfaces under all conditions.

Neafie & Levy Yard.—The Neafie & Levy Ship and Engine Building Company, Philadelphia, Pa., has made a remarkable record for a yard of its size during the past eighteen months. A complete engine has been turned out on an average of every seventeen days, and the minimum size of engine has been 300 horse power. Several of the engines have been of as high a capacity as 3,000 horse power. A new boat is completed every six weeks. The boiler shop, however, has made the record for the establishment. It is only about 50 by 175 ft. and somewhat lacking in the latest improved tools, but there has been turned out 8,700 tons of boilers and fittings during the year past, although the shop was nearly closed for ten weeks for lack of materials. Four vessels are now being finished in the yard. The *Olympia*, *Richmond*, *Corrington* and *Gerry*.

Bolts, Nuts, Anchor Cables, Etc.—A catalogue has just been issued by the American Iron & Steel Company, Lebanon, Pa., referring to the combined business of this company, which purchased the works of the Pennsylvania Bolt and Nut Co., Lebanon Iron Co., and East Lebanon Iron Co., all of Lebanon, Pa., and J. H. Sternbergh & Son, and the National Bolt, Nut and Rivet Works, of Reading, Pa. These plants were among the largest and best of their kind, not merely in the United States, but anywhere in the world, with an established reputation in the field each occupied. The consolidation of the various interests mentioned makes the American Iron and Steel Manufacturing Co. the largest manufacturers of bolts, nuts, rivets, and kindred articles on the globe. The new company employs 4,000 men, and in the department of finished bar iron and steel alone the annual product will be about 150,000 tons. In addition to this large output of bars, the various plants make, on a large scale, all kinds of car forgings, steam railroad and traction forgings, ship yard supplies, ship chandlery supplies, railroad spikes, turn-buckles, washers, etc. Close attention is paid to small orders as well as large ones.

Steam Separators.—The International Navigation Co. has just placed an order with The Potter Separator Co., of No. 39 Cortlandt street, New York city, for sixteen of its Mesh separators.

A Busy Shop.—Owing to the demand for marine engines, centrifugal pumps, machinery and marine boilers, the Kingsford Foundry and Machine Works, Oswego, New York, are running all their departments thirteen hours a day.

Lifting Jacks.—A. O. Norton, manufacturer of ball-bearing lifting jacks, 167 Oliver street, Boston, Mass., and Coaticook, Quebec, Canada, has built a 75 ft. by 35 ft. two-story addition to his Canadian plant, and reports enough orders already booked to keep both plants employed to the maximum of their capacity until April.

Over Clothes.—Engineers and others who use overalls and over clothes will be attracted by the advertisement of Hamilton, Carhartt & Co., Detroit, Mich., who make a specialty of Union made over clothes. This company issues a booklet which will be sent upon request, the only stipulation being that reference be made to Marine Engineering.

Mechanism for Discharging Water.—Users of yachts and vessels will be interested in a mechanism for discharging liquids of all kinds being put on the market by J. George Hermes, 21 Union avenue, Mt. Vernon, N. Y. This apparatus is guaranteed to keep the vessel free from odors which are likely to occur when closets are below the water line. It has been introduced on a number of yachts, among which are the following: *Nourmanhaul, Corsair No. 1, Corsair No. 2, Gloucester, Corsair No. 3, Sultana, Erin, Donthea, Sovereign, Scorpion.*

The Death of Mr. Alteneder.—Theodore Alteneder, head and founder of Theodore Alteneder & Sons, Philadelphia, makers of mathematical instruments, died December 27, aged seventy-seven years. Mr. Alteneder was a native of Bavaria, and came to this country in 1847. He began the manufacture of instruments in Philadelphia, and his inventions and improvements have made his name familiar to the engineering profession. He was a member of the Franklin Institute. Mr. Alteneder had practically retired from business some time ago as the details had been for some time in the hands of his sons.

Launches and Boating Supplies.—An attractive catalogue devoted to the subject of launches, boats, skiffs and canoes has been issued by William Wood, 29 West 125th street, New York. Mr. Wood has a well-equipped factory at 1941 to 1959 Park avenue, where he manufactures his own hulls. He has been in this business fifteen years. He is also interested in skiff and canoe building concerns at Cape Vincent and at Clayton, and is thus well equipped to promptly fill any and all orders for this kind of craft. Mr. Wood also makes a specialty of new and second-hand gasoline, naphtha and steam launches, as well as yacht and ship tenders, and constantly has a number on hand; he also carries a full line of sporting and boating supplies.

Hollow Staybolts.—The increase in steam work has made a great difference in the business of the Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio. One of the latest orders received by the company was for a very large number of these bolts from a leading shipbuilding concern on the Pacific coast.

Deck and Seam Filler.—A tough, elastic and non-shrinking compound, used to fill cracks in decks, seams and floors, is manufactured by the Grippin Manufacturing Company, Newark, N. Y. The claims made for this filler are that it will not break, crack or crumble, is waterproof, but should be protected with paint or varnish. It hardens quickly when applied to a surface that will absorb a portion of the liquid, and is a great saving in labor, as it comes in paste form, and should be applied by the palm of the hand directly to the seams. It is an inexpensive article; one pound is equal to about three pounds of putty.

A New Alco-Vapor Plant.—Owing to the cramped quarters in which it has carried on business for some years, the Marine Vapor Engine Co., Jersey City, N. J., has purchased a large amount of property at First and Middlesex streets, Newark, N. J. The new property gives a frontage of 25 ft. on the Passaic River, and the company is now building a very much larger plant than it heretofore had, so that it will be in condition hereafter to handle all orders promptly. The growth of this company has been marked, as within the past two years it has on two occasions doubled the capacity of its establishment.

Ball-Bearing Bushings.—Owing to the steady demand for Parkin Ball-Bearing Bushings, manufactured by the Pennsylvania Block Co., 2049 North Second street, Philadelphia, Pa., this company incorporated with a capital stock of $50,000 with the privilege of increasing to $100,000. This action was taken because of the great increase in business caused by the demand for ball bearings for so many uses. The plant of the company will be very largely extended at once, so that they can go into the manufacturing of freight trucks, tramway, trolley and vehicle wheels. Within the past thirty days, orders have been received for 35,000 wheels.

Kenwood Steamer Rug.—The well-known Kenwood steamer rug manufactured by F. C. Huyck & Sons, The Kenwood Mills, Albany, New York, is widely used by travelers. As a covering when sitting still in a low temperature nothing has been found to compare with its soft napped woolen fabric. It gives warmth with every inch of its surface, and is light and soft and cannot be disarranged. The only objection to the Kenwood rug ever suggested is that after the traveler returns it cannot be used for a lounge cover. The rugs are now finished in such a manner that they can be easily opened at the bottom and a square rug made, which can easily be closed again into the bag shape of the Kenwood rug. A catalogue is issued by the mills fully illustrating and describing this rug, with the many other specialties manufactured by them.

OIL CLOTHING.—Users of oil clothing will want to have a copy of the price-list just issued by A. J. Towner, Vernon & Simons streets, Boston, Mass. This concern makes a full line of oil clothing and slickers and is the manufacturer of the well-known "fish" brand.

ASHTON VALVE COMPANY.—Mr. H. A. Freeman, formerly connected with the Chicago house of the Ashton Valve Co., has been appointed assistant manager of the New York branch of the same company, located at 121 Liberty street. Mr. Freeman's successful experience in the past as a practical mechanic, engineer and salesman, makes him well fitted to cater to the trade in the New York territory. The Ashton Valve Co.'s business the past year has grown to such an extent that it has necessitated a large amount of night work in its factory. To offset this, and yet be in a position to satisfactorily fill the constantly increasing demand for its goods, the company has decided to enlarge the factory by the addition of another story, giving five floors instead of four. With these increased facilities and the addition of improved machinery, it will shortly be in a position to turn out at least one-third more than has been possible in the past.

BLOCKS AND SHEET LEADERS.—Yachtsmen and others who have occasion to use blocks, sheet leaders, etc., will be interested in the several specialties new this season in the stock of Walter Coleman & Sons, Providence, R. I. Illustrated circulars regarding these blocks are issued by the company.

HANCOCK INSPIRATOR OFFICES MOVED.—The Hancock Inspirator Company, which manufactures the Hancock Inspirator, the Loftus automatic injector, ejectors and general jet apparatus, has moved its general office and salesrooms from Boston, Mass., to 85-87-89 Liberty street, New York city. It is the desire of the company that all inquiries, correspondence, orders and remittances be addressed to the new location, as this will insure prompt reply and greatly facilitate the quick filling of orders. This inspirator has been in the market for twenty-two years, during which time the company says it has made and sold 230,000.

CIRCULATORS AND STEAM JETS.—The business of H. Bloomsburg & Co., Newport News, Va., has been far greater during the past year than ever before in the history of the company. During the month of December, the business of the company included circulators for eight boilers and orders for thirty-four more boilers, with several other orders in prospect. During the month of January this record was equalled, so that the record was brought up to fifty boilers. Among vessels for which large circulators were furnished were the Porto Rican steamers *Ponce* and *San Juan*, which were described in our editorial pages. Several new vessels under construction at the Harlan & Hollingsworth yard will also have Bloomsburg circulators, among the vessels being the Windsor line steamer *Grecian* and the two tugs which have been under construction at Bath, Me., will have these circulators. Several orders have also been filled lately on the Pacific coast, both on this side of the line and the other. The demand for Bloomsburg jets is steadily increasing until now sixty-seven are in use against one hundred and six circulators.

Books for Engineers.—A series of books for engineers is published by Theo. Audel & Co., 63 Fifth avenue, New York. There are five of these books covering fields in engineering work, including electricity, boiler-room practice, and steam engineering. A small catalogue is issued giving some details of what these books contain.

American Steam Gauge Co.'s Removal.—Owing to the great increase in the amount of business, the American Steam Gauge Co., Boston, Mass., has found the quarters it occupied so many years on Chardon street altogether too cramped. A very complete plant has been under course of construction on Boylston street, in Jamaica Plain, Mass. The new establishment will give more than double the capacity of the one previously used, and it is equipped with all the very latest appliances for carrying on the business. As the company is now pretty well settled in its new works, it is in shape to fill all orders promptly for gauges, valves, and its many other specialties.

The Scranton Schools.—The rapid growth and remarkable popularity of schools of correspondence prove that this new system of education meets a distinct want. Starting about ten years ago with a single course in mining, the International Correspondence Schools of Scranton, Pa., have developed so rapidly that they now teach by mail over seventy courses and have over 130,000 students on their rolls. Most of the students are residents of this country and Canada, but the schools have a large following in foreign lands. Students in twenty of the Mexican States are enrolled in the schools, and almost as many European countries are represented. That no country is too remote to be reached by the correspondence school is shown by the records of students in South Africa, Australia, Tasmania, Siam and Korea, who are successfully educating themselves through the courses of the International Correspondence Schools.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

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GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
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GEO. A. GRUBB, National Secretary,
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JOHN McG. STERRITT, 129 Broad St., New York, N. Y.
JAMES H. TAYLOR, 1513 Jefferson St., Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St., Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN McCLURE, 54 High St., E, Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 3111 Dillon St., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St., Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 33 Merrimac St., Pittsburg, Pa.
" 33, W. J. DU BOIS, Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich.
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault St. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M. MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St., Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, FRANK H. GOODELL, 406 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73. E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOFF, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W. Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Sarragossa St., Pensacola, Fla.
" 82, FRED. H. GOWELL, 427 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 12 St. Joseph St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, E. C. DAVIDSON, 29 Congress St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta., Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50, Saginaw, E. S., Mich.
" 93, ROBERT E. L. GRIGSBY, 479 N St., S. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H. BLUMER, Moss Point, Miss

TRADE PUBLICATIONS.

The Boston Belting Co., 256 Devonshire street, Boston, Mass., issues a folder in which it says: "We submit our case, you are the judge" of the various rubber goods this company makes. It is a neat folder.

A half tone engraving of the yacht *Susanne* makes very attractive the announcement of removal issued by Wilson & Silsby, who are now on the North side of Rowe's Wharf, Boston, Mass., with more ample facilities than heretofore.

Sturtevant four pole motors and generators for direct current have a four-page folder devoted to them as Bulletin S., issued by the B. F. Sturtevant Company, Jamaica Plain, Mass. Half a dozen fine engravings of the motors are given.

A combination blotter and calendar is issued by H. Bloomsburg & Co., Newport News, Va., giving a set of four blotters on each of which there are four pictures of leading steam vessels which use the circulators and jets manufactured by this company.

"Direct Current Multipolar Motors" is the subject matter of Bulletin No. 32a, issued by the Bullock Electric Mfg. Co., Cincinnati, Ohio. The motors are illustrated both as a whole and in some of their special parts, and the descriptive matter is very complete.

A large calendar is issued by the Vulcan Iron Works, Toledo, O., for distribution. It would be particularly appropriate to those of our readers interested in the subject of dredging, as an excellent and very large picture of a dredge forms the principal part of the calendar.

"Some Special Dynamos and Motors" is the title of Bulletin No. 131, issued by the C. & C. Electric Co., 143 Liberty street, New York. A number of illustrations are given which show the separate types. Another Bulletin, No. 132, is also ready for distribution, devoted to the four pole dynamos and motors. Copies can be had upon application.

Compressed cork products, manufactured by the Cork Floor & Tile Co., 17 Milk street, Boston, Mass., are fully described in the catalogue just issued. These products are manufactured for floors and tiles, stair treads and sound proofing materials and other purposes, and would be especially interesting to those who own and operate vessels and yachts.

"Modern Pumping Machinery" is the title of a neat catalogue issued by the Deming Company, Salem, Ohio. It refers especially to the triplex power pumps and other small pumps manufactured by this company which are especially adapted for boiler feeding and other purposes. The illustrations give an excellent idea of the variety of these pumps.

"How to increase your income" is the catchy title of an eight page pamphlet of testimonials issued by the International Correspondence Schools, Scranton, Pa. Some refer to marine work, and the statement from a leading M.E.B.A. representative reports the school to be of much value to marine engineers and very helpful to those who wish to qualify themselves for advancement.

A catalogue of about 100 pages has been issued by the American Iron & Steel Mfg. Co., Lebanon, Pa., describing all its products. Many of the products are of much interest to our readers, such as bolts, nuts, boiler and ship rivets, etc. The various products are completely described and illustrated, and many tables are given regarding size, etc. It is a valuable book for reference.

Steam pumps, manufactured by the Union Steam Pump Company, Battle Creek, Mich., are very thoroughly illustrated in a hundred-page catalogue, which is ready for distribution. The large variety of pumps is well illustrated and the descriptive matter is very complete, making the catalogue altogether a desirable one for reference to anybody who is interested in the subject of steam pumps. Copies can be had by referring to MARINE ENGINEERING.

Those of our readers interested in plumbing will want to sand for the pamphlet issued by the Kenney Company, 72 Trinity place, New York, giving a partial list of installations of the Kenney Flushometer system. This list includes many well-known coasting vessels and yachts, both on the sea coast and on the Great Lakes, Government transports, etc., in addition to many buildings.

A supplementary catalogue is issued by the Union Steam Pump Co., Battle Creek, Mich., under the title, "Call of the Hosts." This is not so much a detailed pump catalogue, as it is a talk on the subject of steam pumps and the special features of the pumps manufactured by this company. A number of testimonials are given and the names of many concerns which have been purchasers of these pumps. Like the catalogue, copies can be had by referring to Marine Engineering.

Centrifugal pumping machinery is to be the specialty of the Erie Pump & Engine Co., Erie, Pa., which succeeds to the business of the Davis-Farrar Co. This machinery has a special catalogue devoted to it, which has just been published. Copies are now ready for distribution. The several varieties of pumps are illustrated and described, and tables are given for information regarding revolutions, capacities, etc. Among the pumps illustrated, are submerged and vertical pumps, horizontal pumps, suction pumps, direct connected centrifugal pumps, dredging pumps, etc.

The catalogue on electric power, issued by the Sprague Electric Company some months ago, was in such demand that a second edition has become necessary. It is now ready for distribution, and those of our readers who were not able to secure a copy of the first issue can now be supplied by writing to the Sprague Electric Company, 527 West Thirty-fourth street, New York. This catalogue comprises over seventy pages and is a choice specimen of the printers' and engravers' work. There is a great deal of detail regarding the Lundel motor and nearly half of the book is devoted to pictures giving application of the motors.

Purchasers and users of machine tools as adapted to shipbuilding work will find a very valuable work of reference in catalogue No. 6 which has just been issued by the Hilles & Jones Company, Wilmington, Del. It is a book of 176 pages, bound in board, elaborately illustrated. There is scarcely a page which does not contain a cut, and as the pages are 9 in. square, the cuts are made very valuable for reference because of their size and excellent quality. The catalogue is issued as the preface says "to supply the demand for heavier and more effective machinery with modern labor saving devices." Pretty much every tool that would be used in a steel shipbuilding plant is illustrated and described. There is a very complete line of punches and shears of all sizes and kinds, and adapted to all purposes. Riveting machines, bending and straightening presses, plate planers, plate bending and flanging rolls, straightening rolls and a variety of other tools.

Persons interested in pipe joints will want to send for a copy of the catalogue issued by the Gumbo Cement Company, 161 Lake street, Chicago, Ill. This catalogue describes in much detail the Gumbo cement, which is a substitute for red lead and other materials for making tight steam, ammonia, and other pipe joints. A number of reasons are given why this cement is claimed to be better than lead, and some comparative statements regarding cost, etc., are also given. Copies can be had by mentioning MARINE ENGINEERING.

Users of gas engines will be interested in a catalogue issued by the Lake Shore Engine Works, Marquette, Mich., illustrating and describing the Superior gasoline and marine motor. The features claimed for this motor are many, including simplicity, durability and positive action under all circumstances. The general construction of the engine is well shown, and a good many engravings are given of engines of various sizes. Considerable space is also devoted to reversible propeller wheels and to reversing gears. Copies can be had upon application by mentioning MARINE ENGINEERING.

"Belt Type Machines" is the title of a twenty-four page folder issued by the Crocker-Wheeler Company, 39 Cortlandt street, New York, fully illustrating and very thoroughly describing the dynamos and motors manufactured by this company. The pages are nearly 8 by 10 in. in size, giving opportunity for large and excellent engravings and for ample text to accompany them. Considerable attention is also given to starters, resistance, etc., and many sectional drawings are given of the different sizes of machines. Altogether it is a pamphlet that would be of a good deal of value to an electrical man.

"Corks" is the title to a well printed book which has been issued by the Armstrong Cork Company, Pittsburg, Pa. The cover is an excellent imitation of cork, and the text is very neatly printed in two colors and contains many illustrations. There is a detailed description of the manner in which cork is grown and prepared for the market, and much picturesqueness is added by the description of Spanish life and scenery, whence most of the cork comes. Among other subjects discussed is that of making the Acme cork life preservers, which is a considerable part of the business of this company.

A very handsome and complete catalogue, printed in two colors and giving evidence of being businesslike all through, is issued by the Daimler Mfg. Co., Long Island City, New York. It comprises over fifty pages which give a great deal of information regarding the Daimler engines and their special characteristics. Many pictures are also given of the large and complete shops in which these engines are manufactured, and of the boat department in which the hulls are made. Many pictures are given of the boats and yachts of different types and sizes from small launches up to yachts of 82 ft. or more. Altogether the catalogue is one that every yachtsman and other persons interested in the subject would find of much value.

BUSINESS NOTES.

The New England Company.—During the year 1899 the New England Co., Bath, Me., made an exceptional record, as it launched vessels aggregating 19,957 tons.

The Couse Lubricator.—The Couse lubricator is manufactured by the Couse Lubricator Co., 42 Dey street, New York. It is illustrated and fully described on a card which is being distributed. On the back of the card is considerable information regarding the practical use of these lubricators.

Machinists' Hardware.—Messrs. Charles Besley & Co., 10-12 North Canal street, Chicago, Ill., report a very marked improvement during the past year in the demand for machinists' hardware and other specialties. These include a full line of this firm's manufactures such as taps and die stocks, clamps, Bonanza oil cups and the well-known rust preventative, Mannocitin.

New Alco Vapor Plant.—Owing to the impossibility of securing ample water front to enlarge its plant, the company manufacturing the Alco Vapor engines has taken opportunity during the past winter to build a very complete plant at Harrison, N. J., and the name of the company has been changed to the Marine Engine Co. The main building in the new plant is 200 by 100 ft. with a large gallery in which the machine tools are mostly placed. The main floor is used for hull building and every facility for handling boats and engines is at hand, among others being a traveling crane which commands the entire space. In this new location the company has 130 ft. of water front, with a large yard and spur tracks connecting with the Pennsylvania Railroad. With these facilities, the company, in spite of the great number of orders received, has kept up with work, and in addition to a large amount of yacht work, is now building several lighthouse tenders for the Government.

The Potter Separator.—Every engineer is interested in the subject of dry steam, and will, therefore, probably want to send for the folder issued by the Potter Separator Co., 39 Cortlandt street, New York, which gives considerable information regarding the mesh separator and superheater. This folder tells what it is, what it does, and how it does it, and gives a list of a number of well-known Atlantic steamships upon which it has been installed, the St. Louis having the sixth order.

Hyde Windlasses.—Owing to the very large increase in its business the Hyde Windlass Co., Bath, Me., finds its new plant inadequate, although constructed only two years ago and thought to be large enough to meet all contingencies. A new foundry will be constructed at once and supplied with the latest modern appliances. The recent great increase in shipbuilding on the coast of Maine has caused a large demand for the Hyde windlasses, capstans and other specialties.

Stirling Lubricators.—The Stirling Lubricator Co., Powers' Block, Rochester, N. Y., is putting on the market a new automatic lubricator, which has many special features. It is a gravity feed lubricator and can be adjusted to discharge a specific quantity of oil at regular and defined periods. Some interesting statistics regarding the subject of lubrication are given in a four-page folder issued by this company and any of our readers interested will probably wish to send for a copy.

Eagle Anvils.—The Eagle anvils manufactured by Fisher & Norris, Trenton, N. J., have long had a reputation on the market, as this firm has been established since 1843. The special features of this anvil are well brought out in a four-page folder, which has just been published. Among the special features is the double steel surface on both edges of the face. This circular will be of interest to many of our readers.

A Fine River Boat.—Two carloads of extra choice Douglass fir was recently forwarded from Gray's Harbor, Wash., to the Marine Iron Works, Chicago, Ill. This lumber was used in the construction of a river boat which the Marine Iron Works are building for Mexican parties. It was treated with a special composition which the Marine Iron Works make use of and which they have found to be an effective preservative to wood, especially for boat use.

A Useful Truck.—The McKinney Mfg. Co., Allegheny, Pa., has met with much success in introducing a truck which is especially adapted for handling heavy barrels and boxes with ease and rapidity. It is claimed for this truck that one man can do the work of three who use the old style of truck. All the parts of the truck are constructed of spring steel and the wheels have roller bearings, which it is claimed make it possible for one man to move a load of 1,000 pounds with comparative ease. Some of the special features of the truck add much to its usefulness.

Coleman Blocks.—Users of blocks will be interested in a full line of marine specialties manufactured and carried in stock by Walter Coleman & Sons, Providence, R. I. Among this season's specialties are the Twentieth Century Universal swivel sheet holders, which cannot foul and are always swivelled. A folder is issued which describes this. Another specialty is the bridle block, which has a bridle attachment. The new block Beckert can be applied by a boy to any one of the other Coleman blocks with a mailine spike. A pocket memorandum book is sent to all inquirers, which has the title upon it: "What Congress Has Done for the Boers."

Norwalk Launch Company.—Although organized only a few months ago the Norwalk Launch Co., Norwalk, Conn., has been very much crowded and is already contemplating building an addition 30 by 45 ft. to its present shop. This company is offering a design of its own called the "Norwalk Model," which does not follow the ordinary beaten tracks of launch design, and which is intended to be an improvement on the usual type of hull. This model is built full at the bow, without the customary hollowing at the water line and the widest section is a little ahead of midships. From midship to stern is where the difference between the Norwalk Model and other launches is most apparent. Here there are easy graceful lines and great strength without the customary hollowing. The company is well fitted for work, having a large shop with 8¼ acres of land and 200 ft. of water front.

Boiler Tests.—Those of our readers interested in boiler tests will want to read it in the 1899 report of the Chief of the Bureau of Steam Engineering, U. S. Navy, of the exhaustive tests made of a Babcock & Wilcox boiler, built by the Babcock & Wilcox Co., 29 Cortlandt street, New York, for the *Alert*. Four tests were made and data were taken at twenty-minute intervals. First—time, steam pressure, barometer, temperature of the steam, temperature of the uptake gases, temperature of the air, temperature of the fire-room, draft at base of smoke pipe, draft in back of furnace. Second—records of the weight of water fed into the boiler. The feeding tank was full at the beginning and at the end of the test. Third—records of the coal burned, together with the refuse from the coal and the contained surface moisture. Fourth—records of the tests for quality of steam. The full details of the tests are published in the report, and the results are stated as most satisfactory, the boiler working with good economy under both natural and forced draft.

Large Order for Copper.—The large dry dock which is being built for the Havana Dry Dock Co., Havana, Cuba, calls for a large amount of copper, and an order was placed with the Benedict & Burnham Co., Waterbury, Conn. It is said to have amounted to $25,000.

Catalogue in Preparation.—Manning, Maxwell & Moore, 85-89 Liberty street, New York, have begun work compiling a new catalogue, which shall be devoted exclusively to the illustrating of iron working machine tools. Those of our readers who have any new tools which they desire to have illustrated in this catalogue should communicate immediately with this firm and mark every communication Catalogue Department.

Chicago Nautical School.—The present season is a most prosperous one in the history of the Chicago Nautical School, of which W. J. Wilson, late Lieutenant U. S. N., is principal. Students are applying to this school from all parts of the country and the correspondence course which has recently been established has proved very popular. This school is situated in the Masonic Temple, Chicago, Ill. A little eight-page folder is sent to all persons inquiring and who desire to take a course in seamanship.

Cross Oil Filter.—In a letter to the manufacturers of the Cross Oil Filter, the Burt Manufacturing Company, Akron, Ohio, the president of the Diamond Ice Company wrote as follows: "We are in receipt of your favor of the 29th inquiring if the brass parts in the filter you sold us March 17, 1897, for filtering ammonia oil are still in good condition. We have in reply to say that the filter you have shipped us for use in our ammonia oil has proven to be satisfactory in every particular, in fact to such a degree that we are enabled to recover 95 per cent of the oil used, and that during the past season we were only obliged to purchase for our factory one barrel of ammonia oil. Before we introduced your machine we used about twelve barrels of oil per annum, last year one."

The Paragon Boiler.—A circular recently issued by the inventor of this boiler, Capt. M. DePuy, 19 South street, New York, emphasizes the following points as to why this boiler should be used: (1) Its compactness; (2) is of a kind that lasts 15 to 20 years; (3) has unequaled effective heating surface; (4) entire boiler can easily be kept clean; (5) steams rapidly on half the grate surface used in many boilers; (6) has a large surface of water for steam to emanate from; (7) its side and center legs extend from water front to water back; (8) its double furnaces are entirely surrounded by water; (9) no expensive bracing required over fire boxes; (10) a 100 h.p. Paragon boiler has 200 slot openings over side legs, and one-fifth of shell is cut out over center leg, which insures a free circulation of water throughout the entire boiler; (11) no heat is wasted on expensive brick walls or asbestos casing, which requires continual repairing; (12) is adapted for marine service and stationary plants of every description.

Extending Its Pump Business.—The John H. McGowan Company, Cincinnati, Ohio, which has made a fine reputation for its pumping machinery, has opened warerooms in Philadelphia, which are in charge of Mr. Fred E. Doran, who has been connected with the pump business in Philadelphia for many years, and is very thoroughly known in the trade. The McGowan Co. has recently enlarged its line of pumps so that it covers the field.

An Extended Trip in a Launch.—The launch *Zeta*, which was built and equipped by the Sintz Gas Engine Company, Grand Rapids, Mich., made a very interesting trip lately. She went from New Orleans to Chicago, then from Chicago around to the Great Lakes, to New York, from New York she went down the coast to Florida and then back to New Orleans. The trip was taken by the owner and his wife, family and a cook. The record of the boat on this trip speaks very highly for the qualities of the Sintz gas engine.

Cape Ann Anchor Works.—In spite of the inconvenience caused by the fire in this establishment, reported in October, the Cape Ann Anchor Works, Gloucester, Mass., had a new building so far toward completion that by the middle of October it was running full force. The new building is a much larger and finer one than the old, possessing all the facilities and conveniences for doing forging economically, and the company is now in better shape than ever before to handle the increased business.

Flue Cleaners.—One of the latest flue cleaners to be put on the market is the Ruggles, which is manufactured by the Werner-Schenck Co., 189 Fifth St., Milwaukee, Wis. In order to make it specially adapted for marine work a flexible handle is used, which is made of galvanized steel wire, 3-4 in. diameter. Thus fitted the scraper can be used in any limited space, the wire taking the place of the jointed rods. Engineers who are interested in the subject can get information regarding this from the manufacturers.

Tug Boat James Woolley.—The fine new tug *James Woolley* was given a trial trip in Boston harbor quite lately, in a four-hour speed test, and she averaged over 12 knots in a very rough sea. The *James Woolley* was built for the Commercial Towboat Company. She is of wood, and her dimensions are: Length over all, 92 ft.; beam, 18 ft. 9 in.; depth of hold, 9 ft. 6 in. She is of the ordinary towboat type. Below deck forward is the forecastle, with accommodations for seven men. The galley, engine room and cabin are in the deck house. The interior finish of the boat is white pine, except in the cabin and pilot house, where the finish is of California redwood. The engines are of the vertical inverted compound type, with cylinders 14 and 30 in. in diameter and 20 in. stroke. The boilers are of the firebox flue and return tubular type, 8 ft. 4 in. in diameter and 13 ft. long, built for a working pressure of 127 pounds. The Lockwood Company contracted to build the boat, and the hull-work was sublet to R. F. & W. T. Keough.

Boats for South Africa.—The Truscott Boat Mfg. Co., St. Joseph, Mich., recently shipped four boats to South Africa on order, and another launch to Australia. In its new factory this company is now in shape to fill orders of all sizes with much promptness.

Focusing Lamps and Stereopticons.—J. B. Colt & Co., 404 East Thirty-second street, New York, announce that they are closing out their stock of focusing lamps and stereopticons, in order to devote their entire attention to the manufacture of Criterion acetylene gas generators.

Gravity Boiler Feeder.—A boiler feeder which works on the gravity system has been introduced on the Mississippi River, and is now being extended to other parts of the country. Circulars explaining the working of the system can be had from the manufacturers, the Gravity Boiler Feeder Company, Little Rock, Ark.

New Portable Motor.—The Stow Flexible Shaft Co., Philadelphia, Pa., is putting on the market a new portable compressed air motor for driving flexible shafts, portable drills, portable reamers, etc. This motor is fully described and illustrated in a circular which will be sent to all who are interested in the subject.

Pop Safety Valve and Muffler.—Users of Pop safety valves and mufflers will be interested in the goods manufactured by the Coale, Muffler & Safety Valve Company, Fidelity Building, Baltimore, Md. These mufflers have been very extensively used on locomotives throughout the country and are now being introduced in the marine field. An attractive catalogue, fully illustrating and describing the several specialties manufactured by this company, is sent to all inquirers.

Aluminum Paint.—A new form of aluminum paint, under the name of Lustrogen, has been prepared for sale as the "marine" brand. This paint has a lustrous surface and is easily applied. Its odor is less disagreeable than that of many paints. It is especially adapted for use on boats, yachts, naphtha and electric launches and vessels of all kinds, light-houses, machines exposed to the continual action of the weather, dynamos, cylinder-heads, pulleys, eyes, bolts, nuts, chains, anchors, metal masts and spars, stays, machinery, hulls, bottoms, and all metal and wood work. It is permanent both in air and under water, also oil and grease proof. It is made by L. H. Austen & Co., 52 Beaver street, New York.

Harlan & Hollingsworth Yard.—The S. S. *Grecian* is the fourth ship built at the works of the Harlan & Hollingsworth Co. for the Boston & Philadelphia S. S. Co., familiarly known as the Winsor Line, the others having been the *Indian*, *Spartan* and *Parthian*. She is a three deck freight and passenger steamer, built to rate under the United States Standard for 17 years, has a tonnage of 2483.08; length over all, 290 ft.; between perpendiculars, 263 ft. 2½ in.; beam, moulded, 42 ft.; depth, 36 ft., and will have a draft loaded of 18 to 20 ft. and a carrying capacity of about 2,500 tons. Has four water-tight bulkheads, four hatches, four side ports on each side, four single cylinder Williamson winches, Hyde steam windlass capstan forward and aft, two steel masts, together with steel deckhouse with accommodations for about 100 passengers. Has two electric light plants, 200 lights each, 18-in. searchlight. Inverted triple expansion engines, with four boilers, each with two furnaces built to sustain a working pressure of 170 lbs. Built up cast iron wheel, 15-in. diameter. Ellis & Eaves induced draft; bunker capacity, 275 tons, and is to make a speed of 15¾ knots on eight hours' trial. In addition to this ship the Harlan & Hollingsworth Co. will launch shortly two steamers for the New York & Baltimore Transportation Line, three tugs for the Pennsylvania Railroad, and a ship for the Metropolitan S. S. Co. The Metropolitan S. S. Co. have a sister ship to the *Whitney* on the ways, to be delivered in the early spring, and this is now being rapidly put in frame.

Crumlish Forges.—The Crumlish Forge Co., Buffalo, N. Y., recently moved into new quarters, but finds itself much taxed for space, owing to the sudden and increased demand for forges. For some time past this company has been taxed to its utmost to keep pace with the orders.

Uses for Smooth-on.—A use for Smooth-on which many people appreciate is that of making leaky castings steam tight. This is done by filling the blow holes, holes and other parts with this composition. Casting so treated can be finished, polished and hammered. This material is manufactured by the Smoth-On Mfg. Co., 547 Communipaw avenue, Jersey City, N. J.

Mahogany and Teak.—Users of mahogany, teak, cedar and other woods which would be used in yacht and shipbuilding will be interested in the advertisement of the S. B. Vrooman Co., Ltd., 1133 Beach street, Philadelphia, Pa., as this company makes a specialty of these kinds of wood. It furnishes them in the timber, as lumber and in any size to meet the requirements.

The Barclay Lubricator.—Those of our readers interested in the subject of lubrication will be interested in the concise description of the Barclay patent lubricator, which is sent to all inquirers by the Ashton Valve Co., 271 Franklin street, Boston, Mass. These lubricators have been on the market for some time and are already in use on some of the best known steamship and ferry lines.

"The New Industrial Situation" is the title to a very handsomely published pamphlet with a preface from the pen of George Westinghouse, published by the Westinghouse Companies, Pittsburg, Pa. It refers to the subject of generating power with gas engines. A number of illustrations are given of plants fitted with Westinghouse gas engines, and there is a great deal of information showing the economic value of these plants. Any of our readers interested in the subject will find this publication worthy of careful perusal.

Oil Filters.—The Burt Mfg. Co., of Akron, Ohio, has just completed a shipment of the Cross Oil Filters manufactured by them for the Paris Exposition. These goods are finished especially for their own exhibit and for use in the power house of the U. S. Machinery exhibit there.

A Large Order for Babbitt Metal.—Merchant & Co., Inc., Philadelphia, Pa., have recently received an exceedingly large order for babbitt metal. A large western concern made an exhaustive test of such material of various makes and the result of the test was an order for two carloads of the babbitt metal manufactured by Merchant & Co.

Pocket Map of South Africa.—Those of our readers who are interested in the war in South Africa, will be interested in a pocket map, which will be sent to all who ask for it by mentioning this magazine, by Patterson, Gottfried & Hunter, 146 Centre Street, New York. The map is quite complete and is printed in colors.

Milling Machines.—Users of milling machines will be much interested in the advertisement elsewhere of the combined Becker and Brainard Companies, who have united forces and have moved into a large and very completely equipped plant at Hyde Park, Mass. Any information regarding these machines can be had from the company.

The U. S. Packing.—The annual meeting of the United States Metallic Packing Co. was held at the office of the company last month, Thirteenth and Noble streets, Philadelphia, Pa., and officers elected for the ensuing year. The annual statement showed that the business of the company was the most satisfactory in its history.

A Partnership Incorporated.—Notice has been given that the partnership which has formerly existed under the firm name of the Pennsylvania Block Co., has been dissolved and that the company has been incorporated under the laws of New Jersey. This is done in order to increase the facilities of the company for manufacturing.

Pneumatic Mattresses.—In a booklet issued by the Pneumatic Mattress Co., Reading, Mass., a testimonial is published from the manager of the American Line regarding the pneumatic mattresses used on the steamships *St. Louis* and *St. Paul.* Manager Griscom says: "The mattresses have been very satisfactory, and we will never outfit a steamer with hair mattresses again." Many of the best-known yachts are equipped with these mattresses, and in many cases cushions have been supplied by this company.

TREASURY DEPARTMENT, Washington, D. C., February 20, 1900. SEALED PROPOSALS are invited and will be received at this Department until 2 o'clock P. M. Tuesday, April 3, 1900, at which time and place they will be opened in the presence of attending bidders, for the construction of one steel steam propeller for the U. S. Revenue Cutter Service, for duty on the Pacific Coast, to be known while in course of construction or until launched as No. 8, R. C. S. Said vessel is to be constructed in accordance with the plans and specifications provided by the Secretary of the Treasury, which, together with form of proposal, contract, etc., may be obtained upon application to this Department. Bids must be addressed to the Secretary of the Treasury and be endorsed on the envelope "Proposal for Revenue Steamer for Pacific Coast." The right is reserved to reject any or all bids and to waive defects if deemed for the interests of the Government so to do. O. L. Spaulding, Acting Secretary.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

Geo. Uhler, National President,
1609 Brown St., Philadelphia, Pa.

Frank A. Jones, National Vice-President,
1616 La Fayette St., Alameda, Cal.

Geo. A. Grubb, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

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ADVISORY BOARD.

Joseph Brooks, 6323 Dicks Ave.,	Philadelphia, Pa.
John McG. Sterritt, 129 Broad St.,	New York, N. Y.
James H. Taylor, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, Robt. A. Noone, 498 Swan St., Buffalo, N. Y.
" 2, John B. Heyward, 191 Willard St., Cleveland, O.
" 3, John McClure, 54 High St., E. Detroit, Mich.
" 4, Jas. A. Macauley, 5902 Michigan Ave., Chicago, Ill.
" 5, Harry P. Walker, 3111 Dillon St., Baltimore, Md.
" 9, Wm. Bridges, 784½ 12th St., Milwaukee, Wis.
" 13, Sam'l M. Hall, 2232 S. 5th St., Philadelphia, Pa.
" 15, of New Orleans, La., Alfred Birks, 315 Atlantic Ave., Algiers, La.
" 27, N. P. Slater, 1010 Garfield Ave., Bay City, Mich.
" 30, John W. Farrow, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. Du Bois, Tompkinsville, S. I., New York.
" 35, Wm. Warin, 36 East St., San Francisco, Cal.
" 36, Joseph Thomas, 57 Sea St., New Haven, Conn.
" 37, E. D. Lock, 1304 S. 19th St., Toledo, O.
" 38, W. H. Collier, 73 Starr Boyd Building, Seattle, Wash.
" 39, Frank W. Buchner, 124 Chestnut St., Erie, Pa.
" 40, H. N. Powell, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. Collyer, Goble, Columbia Co., Ore.
" 43, George A. Miller, 828 Wall St., Port Huron, Mich.
" 44, Christ Dahl, 534 W. 2d St., Manistee, Mich
" 46, D. W. Farrell, Clayton, N. Y.
" 47, Archie De Graw, 533 Division St., Sault Ste. Marie, Mich.
" 48, John Erving, 1510 Monroe St., Sandusky.
" 51, Donald McMillan, 105 Fourth St., Muskegon, Mich.
" 53, Harry Stone, Marine City, Mich.
" 55, Archie Stalker Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Rondout, N. Y.
" 58, Geo. D. Anderson, Georgetown, S. C.
" 59, Walter M Miller, 221 Saratoga St., E. Boston, Mass.
" 62, Nathan S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 65, Wm. McCarrel, 8 Vernon St., Charleston, S. C.
" 67, Wm. S. Bradley, Saugatuck, Mich.
" 70, Frank H. Goodell, 406 Bond St., Astoria, Ore.
" 72, Thomas Navagh, 40 Lake St., Oswego, N. Y.
" 73, E. B. Kellogg, 711 W. Walnut St., Green Bay, Wis.
" 76, Orson Vanderhoff, Grand Haven, Mich.
" 77, Jos. Weber, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. Rehder, 29 W Superior St., Duluth, Minn.
" 80, R. P. Cook, 46 Elm St., Albany, N. Y.
" 81, Jas. L. Sweeney, 204 E. Saragossa St., Pensacola, Fla.
" 82, Fred H. Gowell, 4227 Middle St., Bath, Me.
" 84, N. K. Ludlow, 12 St. Joseph St., Mobile, Ala.
" 85, Arthur J. Irwin, 427 Washington Ave., Alpena, Mich.
" 86, Sherman A. Smith, 412 Terrace Ave., Marinette, Wis.
" 87, Geo. B. Milne, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis
" 89, Geo. A. Tate, 141 North Water St., Ogdensburg, N. Y.
" 91, Martin Joyce, 8 Spruce St., Harbor Sta., Ashtabula, O.
" 92, Joseph D. Budd, P. O. Box 50 Saginaw, E. S., Mich.
" 93, Chas. W. Robinson, McGill Building, Washington, D. C.
" 94, Geo. R. Jones, Box 222, Washington, N. C.
" 101, J. C. Billups, Ave. A, Atlantic City, Norfolk, Va.
" 102, Chas. La Bounty, Box 563, So. Haven, Mich.
" 103, C. H. Hall, Box 512, New Berne, N. C.
" 104, J. H. Blumer, Moss Point, Miss.

TRADE PUBLICATIONS.

A pocket map of South Africa is sent to all inquirers by the Durable Wire Rope Co., 234 State street, Boston, Mass., who mention Marine Engineering. This is especially timely, as it shows on a large scale the seat of the war.

A small calendar in the shape of an envelope, with a celluloid binding, is sent to all inquirers by the American Steam Pump Co., Battle Creek, Mich. It is one and one-half inches in size, and among other features it has oiled paper, making it valuable for carrying postage stamps.

A neat calendar containing an excellent lithographed picture of its factory is issued by the American Steam Pump Company, Battle Creek, Mich. There is also an excellent picture of the Marsh pump. The calendar is eight by ten inches in size, and has a silk cord all ready for hanging up.

The C. & C. Electric Co., 143 Liberty street, New York, has issued two pocket-size booklets, which will interest many of our readers. Booklet A gives some of the purchasers of this company's multipolar generators and dynamos. Booklet B some of the electric light and power transmission plants which this company has started.

Rainbow packing, manufactured by the Peerless Rubber Mfg. Co., 16 Warren street, New York, has a twenty-four page catalogue of pocket size devoted to it. This catalogue is printed in red and blue, and takes up the subjects in turn of the various types of packings manufactured by this company. Copies can can be had for the asking, by referring to Marine Engineering.

The New England School of Engineering, 121 Haverhill street, Boston, Mass., has ready for distribution a neat pamphlet describing the advantages of this school. As stated in the text, these advantages not only include instruction by practical men, but opportunities to examine, take apart and put together a large variety of engines, pumps, etc., which are used especially for such purposes in one department of the school.

Lozier motors and launches have a very artistic catalogue devoted to them issued by the Lozier Motor Company, Toledo, Ohio. A number of pages are used in describing, in considerable detail, the special features of the motors, and following this are a number of pictures of the different styles of launches and boats which are furnished when desired. This feature of the catalogue is quite complete.

Smooth-on compound for shipbuilders, engineers, machinists and others is fully described in a new catalogue just issued for distribution. It comprises thirty-two pages, and contains much valuable information on the subject. The process for making this compound is explained, and its uses are thoroughly gone into. There are also a number of testimonials given from people who have found Smooth-on of much value. There is scarcely a reader of Marine Engineering who will not find this catalogue well worth reading. Copies can be had from the Smooth-On Mfg. Co., Jersey City, N. J.

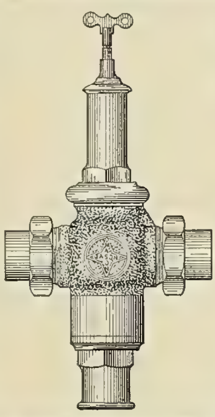
Steam jet pumps manufactured by the E. W. Vanduzen Company, 104 East Second street, Cincinnati, Ohio, are fully described in catalogue No. 62, which is now ready for distribution. This catalogue comprises about fifty pages, and contains a good deal of valuable information regarding these pumps. Many references are given by users of the pumps, showing "why our pumps will work." A number of illustrations show the construction of the pumps, and there is much detail regarding the material used, capacities, steam pressures, etc. Several pages are also devoted to the other specialties which this company manufacture, such as brass syphons for steamboats, barges, and for drainage pumps. A large illustration of an application of the pump on board a steam vessel is given, and several pages are filled with hints for users of the pumps.

Users of varnish will be interested in a pocket memorandum book in diary form, which is sent to all inquirers by the David B. Crockett Company, Bridgeport, Ct. In addition to a complete diary for the year there is much valuable information regarding the value of foreign coins and a concise statement of stamp taxes and what documents it is necessary to use stamps on, together with much information which people should have at their finger points, such as hints in case of accident or drowning, postage and money order rules, weights and measures, etc.

The Sturtevant generating sets were quite fully described in a folder issued some months ago. The demand for these folders was so great that the edition was soon exhausted, and it has now become necessary to issue a third edition. This edition has been brought up to date, and it makes an unusually valuable one on the subject of direct connected electric plants. Sets of various sizes are illustrated and described from the little compact twenty-five light set to the larger one of seventeen hundred or more lights. Any of our readers interested can have a copy of this edition, by mentioning MARINE ENGINEERING, and writing to the B. F. Sturtevant Co., Jamaica Plain, Mass., for Bulletin G.

Two very artistic pamphlets, 3 1-2 by 6 in. in size, have just been issued by the Boston Belting Company, 256 Devonshire street, Boston, Mass. The one devoted to packing is very neatly printed in two colors, red and gold, and comprises over forty pages. These pages are very fully illustrated in a most excellent manner, and are devoted exclusively to the subject of the various kinds of packing manufactured by this company. The description is sufficient to completely and well explain the various kinds of packings referred to. The second booklet is bound in a sage green cover, and is devoted to the subject of hose, both cotton and rubber, and the various attachments used.

The Dearing water tube boiler is well illustrated and described in a catalogue which has just been issued. As stated in the introductory, this boiler has been in practical use for seven years, and a number of testimonials are given speaking in high terms of this boiler by those who have used it. Several distinctive features of the boiler are briefly referred to, and following this is a description of the boiler itself. Two illustrations are given showing the manner in which the generating pipes are arranged and their relation to the furnaces and steam drum. Following these are pictures of the boiler, complete with casing and all attachments. Another illustration shows the relative size of the different boilers, one being the number eight and the other the number twenty, the largest size yet made. The construction of the boiler is referred to in considerable detail, and the drum and the frame are illustrated separately, so that the description of these features is made clear. The catalogue is one that will be of interest to those of our readers who care to investigate the subject of water tube boilers.



Steam Traps is the title to a sixteen page booklet issued by the William S. Haines Co., 136 South Fourth street, Philadelphia, Pa. As stated on the cover, "this is an interesting little story for any man who has to pay coal bills." The pages are printed in two colors, and there is a good deal of information regarding the subject of steam traps in general, and the Heintz in particular, which is the trap manufactured by this company. Many testimonials are given, which speak in high terms of these traps, which have been introduced in both the marine and stationary fields.

The pneumatic rammer manufactured by the Philadelphia Pneumatic Tool Co., Stephen Girard Building, Philadelphia, Pa., has a neat folder printed in two colors devoted to it. This tool is designed especially for use in foundries, and has many features which will be of interest to those who have use for such a tool. The pneumatic hammers which are manufactured by this company are also illustrated and briefly described in this folder. Other folders also describe the rotary drills and reamers. As pneumatic tools are now very extensively used in shipyard work, many of our readers will be interested to send for copies of this circular.

Users of small motors will be interested in two issues of the *Horseless Age*, 150 Nassau street, New York city. One issue is called the Explosive Motor number. This issue illustrates and describes the explosive motor, and contains much valuable information to anyone who uses a motor of this type for launches and automobiles. The subject is divided into special heads, such as ignition troubles, coils and sparks, vibration, gasoline mixtures, multicylinder engines, etc. Several pages are devoted to discussing explosive motors in detail. This article also occupies ten pages, and is well illustrated. Another issue of this publication is the Steam Boiler number, limiting itself to the small steam plants for motor vehicles, although the matter will probably be equally appropriate to small launches. Each publication is sold for ten cents, postage paid.

River Navigation is the title to a business-like presentation of the matter of river boats "for those who have had a limited experience" in this line of work, issued by the Marine Iron Works, Station A, Chicago, Ill. It comprises over twenty pages, and is a very practical presentation of the subject. It describes light draught, stern wheel and paddle wheel steamboats, more from a business than from a technical point of view, and contains much information of boats varying in length from fifty to one hundred and twenty-five feet. A number of drawings are given of different types and sizes of boats, and much other information is given, making the pamphlet of value to our readers who are at all interested in the subject of river navigation. As the Marine Iron Works have devoted themselves for many years to this line of work and have supplied many boats in South and Central American waters, as well as for use in Alaskan waters, this pamphlet is the expression of long experience.

Users of mahogany, teak, cedar, and other special woods for ship and yacht building will have sent to them upon inquiry a very handsome memorandum pocket-book by the S. B. Vrooman Co., Ltd., 1133 Beach street, Philadelphia, Pa. This is a memorandum-book and pocket-book combined, and there are a few pages of information, which would be valuable, such as what kind of documents require revenue stamps; also important points regarding laws for daily use. As the pocket-book is an exceptionally strong and valuable one, inquirers should use their proper letter heads and mention MARINE ENGINEERING.

A very handsome souvenir of the races between the Columbia and Shamrock is issued by Walter Coleman & Sons, Providence, R. I. It comprises two pictures handsomely mounted on green board. The upper picture is eight by eight inches in size and shows the two yachts under full sail, the Columbia just crawling out from under the Shamrock's lead. The lower picture, somewhat smaller in size, shows the Columbia under full sail forging ahead for the outer mark. The pictures are in two colors and are very excellent. The size of the souvenir is 20 by 12 inches. A charge is made for it by the publishers, Walter Coleman & Sons, Providence, R. I.

Olympia Asbesto Metallic goods manufactured by the C. W. Trainer Mfg. Co., 89-91 Pearl street, Boston, Mass., have an eight page catalogue devoted to them. The several specialties shown include the Olympia asbesto metallic woven sheeting, the construction and special features of which are described, also asbesto metallic woven tapes, asbesto-metallic woven gaskets, and asbesto-metallic piston packings. These specialties are a combination of asbestos and India rubber, with a fine brass wire spun into the warp and weft of the cloth. Directions are also given for using the Olympia asbesto metallic rope packings. Copies of this booklet are now ready for distribution.

BUSINESS NOTES.

MALLEABLE IRON CLAMPS.—Boat and vessel builders will find a large variety of malleable iron clamps described in a circular issued by Hammar & Co., Branford, Conn. These clamps are made in different types and vary in size from two inches to eight inches. The patent clamps have some special features which will attract attention at once.

SET OF COLD CHISELS.—In addition to the set of scraping tools which the Mound Tool and Scraper Co., 712 Howard street, St. Louis, Mo., sells, it is now offering a set of five cold chisels. This set includes a flat chisel, a narrow key chisel, a bent grooving chisel for cutting oil ways in engine brasses and bearings, a diamond-point chisel and a calking tool suitable for calking seams and rivets of boilers.

BALL BEARING TRUCKS.—The Pennsylvania Block Co., 2049 North Second street, Philadelphia, Pa., recently received an order for fifty trucks for the Philadelphia Dryer Machinery Co., and this order has been followed by an order for two hundred and fifty more of the same kind of trucks. An order for one hundred and thirty-six trucks was placed by the Shannon Hardware Co., and now this order has been followed by one for eight hundred more of the same pattern. All of these trucks were fitted with the Parkin Ball bearings, which have been used so extensively in ship blocks and for other uses.

CORRESPONDENCE SCHOOLS.—We are informed that the International Correspondence Schools, Box 1111, Scranton, Pa., though only established nine years, have 160,000 students and graduates. These schools do nearly all of their teaching by mail, and therefore it makes no difference in what part of the world the students live. Many students are employed in the Navy and on ocean going vessels. On the *Olympia*, for instance, we are informed that there were several students. On the Great Lakes the number of students is very large, and along the coast many young men are taking up courses in order to fit themselves to supply the great demand there is for educated engineers. A nautical course is now under preparation and will soon be in shape to accept students.

PARAGON BOILERS.—We are informed by Capt. M. De Puy, 19 South street, New York, that he is having an unexpected demand for his Paragon boilers, and has not as yet been able to keep up with the orders. He is now, however, making arrangements with boiler builders in various parts of the country, and expects soon to be able to fill all orders promptly. Shop rights have just been sold to Walsh & Weidner, Chattanooga, Tenn., who will build these boilers for the Southwestern States, and who already have several orders on hand. The inventor has just received an order for six boilers for marine uses from forty horse power to three hundred. The inventor stands ready at any time to demonstrate the advantages of the Paragon boiler over other patented boilers.

CROSS OIL FILTERS.—One of the largest orders for oil filters has just been placed with the Burt Mfg. Co., Akron, Ohio, who manufacture the Cross oil filter. The order comes from Yokohama, Japan. Two other large orders just received by this company were from the Lehigh Valley Coal Co. for nine filters, and the American Tin Plate Co. is placing the twelfth order. The Burt Co. is so confident as to the many good qualities of its filter that it offers to send one on thirty days' trial, and if the filter does not equal the claims made for it it can be returned at the expense of the manufacturer. A very complete catalogue descriptive of this filter is sent to all inquirers. The Metropolitan Supply Co., of London, England, one of the largest electrical concerns in the British empire, has recently placed an order for four 90 gallon Cross oil filters, and the British government has sent in large orders during the past year.

FRICTIONLESS BEARINGS.—Many of our readers will be interested in the claims made by the Graphite Lubricating Co., 10 Church street., Bound Brook, N. J., for their graphite bearings, which run without oil or grease. A good illustration of what this bearing will do is shown by the following letter from the Moore & White Co., Philadelphia, Pa. This letter says: "In October, 1880, we erected a counter shaft with a friction clutch pulley 15 in. diameter, 8 in. face, 2 2-16 in. bore, running 439 revolutions per minute to drive our dynamo. This pulley was bushed with one of your graphite bushings and has been running continuously ever since, running about eight hours every day, loose on the shaft, as the dynamo has only been used for light. This pulley has not been oiled more than two or three times, and then by mistake, and it apparently is in as good condition as when put up. We would say further that we have used a great many of your bushings and have found them very satisfactory." These bushings are adapted to nearly all uses for which bearings are used, and many of our readers will be interested in the catalogue which tells of them.

OVERALLS AND COATS.—In order to more thoroughly introduce their overalls and coats, Hamilton, Carhartt & Co., Detroit, Mich., offer to send to all inquirers a sample of the cloth of which the garments are made, and a blank for self-measurement, together with a tape measure for measuring. This tape measure is sent free. The goods are sold with the charges for delivery paid. This business, which was started by Mr. Carhartt a few years ago, has extended until it now gives employment to over four hundred operators. The factory is new and complete in all its equipment and offers every facility for the employees to be comfortable. The special claims for the success of this company are well shown in a handsome catalogue just issued, which says, "We have always made honest goods. We have always been honest with our employees."

PITTSBURGH FEED WATER BOILERS.—A charter was granted March 14 under the laws of the State of Pennsylvania to the Pittsburgh Feed Water Heater Co., Pittsburgh, Pa., for the manufacture of feed water heaters, etc. James Bonar, president; J. E. Schlioper, treasurer and general manager, and Joseph Cawley, secretary. The sales department will be under control of James Bonar & Co., Pittsburgh, as heretofore. The company will manufacture both the Pittsburgh Feed Water Heaters and Purifiers, and also the Pittsburgh Tubular Feed Water Heaters. These heaters have been in use for the last six years, and are being adopted by some of the leading steam users. The Carnegie Steel Co., Ltd., alone having installed over 50,000 horse-power, and there being 300,000 horse-power in use throughout the United States. It is the intention of the company to push the sale of these heaters to a greater extent than in the past, and the company is desirous of making connections with different concerns throughout the United States to take hold of this product.

FIRE PROOFING WOOD.—The Underwriters' Bureau of Fire Protection Engineering, in a report on the process of fireproofing wood as treated by the American Wood Fireproofing Company, 11 Broadway, New York, reaches the following conclusions: Extended experiments and tests show that wood treated by this process will not flame or support combustion. The application of an intense heat will cause charring and slow disintegration in a glowing condition with little or no flame. The gradual consumption of wood under such conditions is not conducive to the spreading or conveying of fire, and is entirely local in its effects. Wood subjected to this treatment would appear to retain indefinitely its fire-proofed qualities under conditions ordinarily met with in practice. The electrical insulating properties are not sufficiently decreased to prevent the recommendation of this wood as a material for wire mouldings. The preservative properties of this wood, due to the removal of saps subject to fermentation and the substitution therefor of crystallized salts, renders dry rot and similar conditions improbable.

STANDARD THERMOMETERS.—The Standard thermometers manufactured by the Helios-Upton Company, Peabody, Mass., are particularly desirable because of the difficulty encountered in reading the ordinary mercurial thermometer. This thermometer is designed and constructed on the latest scientific principles, and the hand placed over the dial indicates the temperature as clearly as the hands of a clock show the time. The figures on the dial are so clear that they can be read a number of feet away. This company has supplied these instruments to a great many steamship lines, and they are extensively used in the navy. They are made into all sizes, to suit the various conditions.

READY ROOFING.—Many advantages are claimed for the ready roofing which is manufactured by the Asphalt Ready Roofing Co., 136 Water street, New York. As its name implies, the roofing is always ready for use and the process of laying it is so simple, that any man with ordinary mechanical sense can do the work. There is little dirt or rubbish when this roofing is laid, as it comes all prepared to be laid. As asphalt is used it is claimed to be far more durable than would be coal tar. This roofing is suitable for any roof, either flat or slant, and an important feature is that no painting is necessary. Each roll of the roofing has a smooth edge, which runs the entire length, insuring tight joints and enabling the men laying the roofing to know just where the laps are to be made. This roofing is extensively used on buildings in shipyards and on wharf buildings, as it withstands the action of the elements exceptionally well.

THE OLDS NEW PLANT.—Owing to the great expansion in its business, the Olds Gasoline Engine Works have removed their headquarters from their former shops in Lansing, Mich., to Detroit, Mich., and the name of the company has been changed to the Olds Motor Works. This company began business in 1885 in a little shop 18 by 26 ft. in size. This plant has gradually been extended, but has now been given up for the new plant at Detroit, which is situated on four and one-half acres of ground extending from Jefferson avenue to the river. These shops have 110,000 square ft. of floor space. The machine room alone is 300 by 70 ft., and is fitted with the latest appliances, such as overhead electric cranes, and every possible convenience for turning out engines of the best quality in the shortest time possible. The foundry is equally complete, and is 170 by 70 ft. in size. There are also storage vaults for patents, testing rooms above the shops, and a very large and well arranged warehouse and salesroom. This company devoted itself originally to stationary engines, but has recently taken up the marine type of gas engines, and with its new plant will be able to fill all orders promptly. The Lansing plant will continue to be operated, but only for the making of stationary engines. In the Detroit works special attention will be given to motors for launches and motor vehicles.

New York Blower Co.—The new shops of the New York Blower Co., Bucyrus, Ohio, although designed to be ample for a large increase in business, are now well tested in their capacity. Orders are being filled promptly, however, as night work has recently become necessary. This company makes a full line of heating and ventilating apparatus, such as blowers, exhausters, heaters, engines, etc.

Yachts and Launches.—Now that the Marine Engine Co. is fully settled in its plant at Harrison (Newark), N. J., it has branched out and is making a special line of steam launches and yachts in addition to the well-known alco vapor launches. The company has every facility for building and designing hulls, and all the work will be done under its own supervision.

Quiggins Patent Evaporator.—A catalogue has just been issued by the James Reilly Repair and Supply Co., 230 West street, New York, describing in much detail the evaporator and distilling apparatus of which this company is a large manufacturer. Regarding the matter of fresh water on board ship, the catalogue says. a fair average requirement for a plant in ordinary good condition is about 3 tons of auxiliary feed water per 24 hours for each 1,000 I. H.P. of the machinery. There are two ways in which the fresh water needed can be supplied—the storage of a supply in special tanks or double bottoms, and distillation from sea water. The former has the objection of increasing the displacement of the vessel and is only applicable, as a rule, in vessels making regular trips between large ports. The latter, when properly arranged, makes ample provision, as long as there is coal to raise steam. It has, further, the great advantage of providing absolutely pure water for drinking purposes, which is a specially valuable feature for naval vessels, yachts, &c., which go to all parts of the world. The distillation of fresh water from sea water necessarily involves the formation of scale, and the evaporator was invented to provide for the supply of heat from steam, instead of hot gases (as in a boiler), so that even when neglected there is no danger of injury to any part of the apparatus, and the removal of the scale is a simple and easy process. The heating surfaces are very accessible, and so arranged as to be easily removed and thoroughly scaled in a short time.

New Pipe Unions.—Users of pipe unions will be interested in a new union which is being put on the market by the A. E. Dart Union Co., Woburn, Mass. By a ball joint arrangement of the flange it is possible to make a tight joint even if the pipes are not in line—in fact, it is claimed they can be 10 degrees out of line and be made tight. The unions are made of steel castings and are quite heavy, having octagonal ends so a wrench can be used.

Ball Bearing Jacks.—Harry A. Norton, representing the firm of A. O. Norton, 167 Oliver street, Boston, Mass., is making an extended trip to Mexico and the Pacific coast, in the interest of the Norton ball bearing jacks. He reports that business is exceptionally good, and has found much interest among shipbuilders in the Norton ball bearing jacks. Mr. Norton is selling not only the smaller size of jacks, which the Government takes it for granted are carried on every steam vessel of any size, but is also meeting with much success in introducing the larger jacks, which would be used in shipyards.

Harlan & Hollingsworth Yard.—The Harlan & Hollingsworth Company, Wilmington, Del., is feeling the full effect of the great demand there is for new vessels. During the past few days the company has contracted with C. M. Mallory & Co., of the New York & Texas S. S. Co., for a freight and passenger steamer, the first one of three such vessels. This will be one of the largest vessels ever built for coastwise trade, and the largest ever built at this yard. She will be about 400 ft. long, and is to have a speed of about sixteen knots. The company also has orders for six large steel sea going barges. The Winsor Line Steamship *Indian* is about to be hauled out in the Harlan & Hollingsworth yard to be lengthened 40 ft. Another fine order just received by these builders is for a steam yacht for Charles Fletcher, Providence, R. I., to be 212 ft. long and to have twin screws.

Forced Draft in Yachts.—The essential advantages of forced draft on board steam vessels was clearly presented in these columns lately. In connection with this subject the B. F. Sturtevant Co., Jamaica Plain, Mass., make an interesting point aside from the mere question of the weight of steam plants. In a communication it says: Two boilers working under forced draft must necessarily take up much less room fore and aft than four or five boilers working with natural draft. Two large yachts at present building have the same power. One is to obtain the power with natural draft and the other is to use forced draft. If the coal capacity and dimensions of the vessels were the same, the total fore and aft length of their machinery would be 102 ft. in the natural draft boat, against 86 ft. in the forced draft boat, which means that the vessel using forced draft has 16 ft. more room fore and aft to be used for the accommodation of the owner and his guests.

Soft Metal Hammers.—Soft metal hammers which are so extensively used in machine shops and in engineering work have the unfortunate tendency to be used up quickly. In order to make it possible to melt over these hammers and to keep a supply in stock at a minimum cost, Charles H. Field, 254 Chestnut street, Providence, R. I., has met with much success in introducing his combination mould and ladle for casting these hammers. The ladle is attached to the mould, and when the metal becomes molten it is poured into the mould, a simple operation, because of the mould and the ladle being in one piece. The operation is so simple that any boy can do the work. The handle consists of an ordinary piece of pipe forged so as to form a T shaped end. Mr. Field furnishes the articles and sells the complete device for a sum which is very small compared to the value of the product. The ladle can be used for other purposes, such as babbitting bearings, etc. A circular giving a full description of this device is now ready for distribution. It is fully illustrated. Copies can be had by any of our readers upon application.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

Yachtsmen's Supplies.—Those interested in yachts and launches will want to send for a copy of a catalogue on the sporting goods of all kinds, issued by William Wood, 25 West 125th street, New York. The catalogue gives a complete list of yachting supplies of all kinds, such as oars and paddles, canoes, and all the fittings that go with them; row boats, skiffs of all kinds, together with launches, new and second-hand gas engines, etc.

Deck and Seam Filler.—This is the season of the year when on yachts and vessels of all kinds it is desirable to protect wooden surfaces as much as possible. A check and seam filler, manufactured by the Grippin Mfg. Co., Newark, N. Y., is made especially for this purpose. The claim is made that it will not break, crack, shrink, or crumble, and will withstand any action of the elements. It is water proof. It is sold in the form of paste, and is a very desirable article for filling up checks and cracks.

The Sportsmen Show.—The Sportsmen Show, which was held in Madison Square Garden, New York, last month, under the auspices of the Sportsmen Association, 313 Broadway, New York, had several exhibits which would be of much interest to our readers in the line of gas engines and launches. Among the exhibitors were the Sintz Gas Engine Company, Grand Rapids, Mich.; Lozier Motor Co., Toledo, Ohio; the Pennsylvania Iron Works, Philadelphia, Pa., manufacturers of the Globe gas engine; Truscott Boat Manufacturing Co., St. Joseph, Mich.; the New York Kerosene Oil and Engine Co., 31 Burling slip, New York, and the Standard Motor Manufacturing Co., 1945 Park avenue, New York. The rest of the exhibits were largely devoted to other sports, such as shooting, ice boating and canoeing. Special features each evening were aquatic sports. This show has now evidently become an annual institution and seems to be more popular each year. The many live animals, game birds and fishes attracted much attention.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

Geo. Uhler, National President,
1609 Brown St., Philadelphia, Pa.

Frank A. Jones, National Vice-President,
1616 La Fayette St., Alameda, Cal.

Geo. A. Grubb, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

Ed. R. Blanchard, National Treasurer,
583 Fort St. E., Detroit, Mich.

ADVISORY BOARD.

Joseph Brooks, 6323 Dicks Ave.,	Philadelphia, Pa.
John McG. Sterritt, 129 Broad St.,	New York, N. Y.
James H. Taylor, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, Robt. A. Noone, 498 Swan St , Buffalo, N. Y.
" 2, John B. Heyward, 191 Willard St., Cleveland, O.
" 3, John McClure, 54 High St., E. Detroit, Mich.
" 4, Jas. A. Macauley, 5902 Michigan Ave., Chicago, Ill.
" 5, Harry P. Walker, 3111 Dillon St., Baltimore, Md.
" 9, Wm. Bridges, 784½ 12th St , Milwaukee, Wis.
" 13, Sam'l M. Hall, 2232 S. 5th St., Philadelphia, Pa.
" 15, of New Orleans, La., Alfred Birks, 315 Atlantic Ave., Algiers, La.
" 27, N. P. Slater, 1010 Garfield Ave , Bay City, Mich.
" 30, John W. Farrow, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. Du Bois, Tompkinsville, S. I., New York.
" 35, Wm. Warin, 36 East St., San Francisco, Cal.
" 36, Joseph Thomas, 57 Sea St., New Haven, Conn.
" 37, E. D. Lock, 1304 S. 19th St., Toledo, O.
" 38, W. H. Collier, 73 Starr Boyd Building, Seattle, Wash.
" 39, Frank W. Buchner, 124 Chestnut St., Erie, Pa.
" 40, H. N. Powell, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. Collyer, Goble, Columbia Co., Ore.
" 43, George A. Miller, 828 Wall St., Port Huron, Mich.
" 44, Christ Dahl, 534 W. 2d St., Manistee, Mich
" 46, D. W. Farrell, Clayton, N. Y.
" 47, Archie De Graw, 533 Division St., Sault Ste. Marie, Mich.
" 48, John Erving, 1510 Monroe St., Sandusky.
" 51, Donald McMillan, 105 Fourth St., Muskegon, Mich.
" 53, Harry Stone, Marine City, Mich
" 55, Archie Stalker Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. Meeker, 71 Abeel St., Rondout, N. Y.
" 58, Geo. D. Anderson, Georgetown, S. C.
" 59, Walter M Miller, 221 Saratoga St., E. Boston, Mass.
" 62, Nathan S. Lawrence, 30 Connecticut Ave., New London, Conn.
" 65, Wm. McCarrel, 8 Vernon St , Charleston, S. C.
" 67, Wm. S. Bradley, Saugatuck, Mich.
" 70, Frank H. Goodell, 406 Bond St., Astoria, Ore.
" 72, Thomas Navagh, 40 Lake St., Oswego, N. Y.
" 73, E. B. Kellogg, 711 W. Walnut St., Green Bay, Wis.
" 76, Orson Vanderhoff, Grand Haven, Mich.
" 77, Jos. Weber, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. Rehder, 29 W Superior St., Duluth, Minn.
" 80, R. P. Cook, 46 Elm St., Albany, N. Y.
" 81, Jas. L. Sweeney, 204 E. Saragossa St., Pensacola, Fla.
" 82, Fred H. Gowell, 4227 Middle St., Bath, Me.
" 84, N. K. Ludlow, 12 St. Joseph St., Mobile, Ala.
" 85, Arthur J. Irwin, 427 Washington Ave., Alpena, Mich.
" 86, Sherman A. Smith, 412 Terrace Ave., Marinette, Wis.
" 87, Geo. B. Milne, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. Chapman, S. B. Canal, Sturgeon Bay, Wis.
" 89, Geo. A. Tate, 141 North Water St., Ogdensburg, N. Y.
" 91, Martin Joyce, 8 Spruce St., Harbor Sta , Ashtabula, O.
" 92, Joseph D. Budd, P. O. Box 50 Saginaw, E. S., Mich.
" 93, Chas. W. Robinson, McGill Building, Washington, D. C.
" 94, Geo. R. Jones, Box 222, Washington, N. C.
" 101, J. C. Billups, Ave. A, Atlantic City, Norfolk, Va.
" 102, Chas. La Bounty, Box 563, So. Haven, Mich.
" 103, C. H Hall, Box 512, New Berne, N. C.
" 104, J. H. Blumer, Moss Point, Miss.

TRADE PUBLICATIONS.

The combination mold and ladle for casting soft metal hammers, which is made by Charles H. Field, Providence, R. I., is described in a four page folder which has just been issued. The folder is well illustrated and enough descriptive matter is given to give a good idea of the value of this mold.

The Ball Bearing Company, Watson street, Boston, Mass., has issued a new catalogue which is described as the Twentieth Century Catalogue. It comprises nearly fifty pages and gives a great deal of matter regarding the thrust bearings of various kinds and other specialties in the line of ball bearings which this company manufactures. A list of some of the users of these bearings is also given.

The Peerless Rubber Mfg. Co., 16 Warren street, New York city, has just issued catalogue No. 32. It comprises 136 pages which are printed in red and black and many pages of which are fully illustrated. The typographical work is excellent and from a practical point of view almost everything that can be asked for in the line of rubber goods is illustrated and very completely described. Copies can be had by referring to Marine Engineering.

The Olds Motors, marine, stationary and automobile, have a catalogue of fifty pages devoted to them. In this catalogue large and excellent engravings of both the Detroit and Lansing works of the company are given. The marine type of engine including the various sizes from the smallest up to the 30 or more horse power is described and illustrated. Several types of launches are also shown and a number of automobiles equipped with engines of this make are illustrated and described.

Valve reseating specialties manufactured by the Leavitt Machine Co., Orange, Mass., are fully described in a 46 page catalogue, which has just been issued. The catalogue is pocket size and is very fully illustrated with pictures of some of the vessels of the Navy which have on board the valve reseating machine manufactured by this company. The pictures of these vessels are excellent and a good deal of information is given regarding these reseating machines, not only in describing their construction, but their manner of operation and the various styles manufactured.

Marine engines, boilers and steamboat machinery of all kinds handled by Charles P. Willard & Co., 43 South Canal street, Chicago, Ill., have a neat catalogue devoted to them. Nearly all of our readers will be interested in this catalogue, as it illustrates and describes quite a line of marine engines, from the small simple one to the large compounds. Considerable attention is also given to the various types of boilers from the small vertical type to the larger Scotch type and to the Willard water tube boiler. This boiler is very well illustrated and several pages are devoted to a description of it. Considerable attention is also given to steamboats and steamboat machinery for use in shallow draft water.

The catalogue for 1900 of the Ashcroft Mfg. Co., 85-87-89 Liberty street, New York city, is composed of over sixty pages and has a complete index and table of contents. The pages are 6 by 9 in. in size and on nearly every page is an illustration taking from one-third to one-half of the space. The many specialties illustrated and described include a large variety of marine goods, such as cocks of all kinds, revolution counters and all other engine and engine room supplies, together with stocks and dies, wrenches, etc. The catalogue is well printed on a good quality of paper and in type of good size; in short, it is an excellent, complete and very handsome catalogue. We have no doubt that any of our readers who are purchasers of any of the specialties mentioned can secure copies by mentioning Marine Engineering.

A pamphlet describing the paints manufactured by the Goheen Mfg. Co., Canton, Ohio, is being distributed. Considerable information is given regarding the protective qualities of these paints.

Great Western files which are handled by Patterson, Gottfried & Hunter, Ltd., 146 Centre street, New York city, have their good qualities well depicted in a small hanger about 5 by 6 in. in size, which is just issued. It is lithographed in several colors.

An attractive calendar is issued by E. A. Burnside, Point Pleasant, W. Va. At the top of it is a picture in colors of several sheep being guarded by a shepherd dog. Below is mentioned a large number of the marine specialties which Mr. Burnside handles.

Users of gasoline engines for launches will be interested in a catalogue issued by the Rochester Gas Engine Company, Rochester, N. Y. The engines are described in some detail and the style of reversing gear which the company has adopted is also shown.

The machinery, metals, hardware tools and other supplies handled by Patterson, Gottfried & Hunter, Ltd., 146 Centre street, New York city, are very well described in a catalogue just issued. This company handles the products of a number of leading manufacturers and among the specialties described in this catalogue are lathes, milling machines, jacks, etc.

"Evaporating and Distilling Apparatus" is the title to the latest catalogue issued by the James Reilly Repair & Supply Company, 229 West street, New York city. The description gives a very complete idea of the design of the Quiggins evaporator. Distilling apparatus is fully described and quite a little attention is given to condensers, feed water heaters, etc.

Barrow and truck catalogue No. 9 has just been issued by the Syracuse Chilled Plow Company, Syracuse, N. Y. It comprises fifty pages, which are fully illustrated, nearly half of them being devoted to barrows of various types, both wood and steel. A line of trucks such as would be used in wharf warehouses or on board ships is very complete and many styles are shown from the small light ones to the "Hercules" type.

"Do You Know" is the title to a sixteen page booklet, very neatly printed on green tinted paper and bound in heavy red board issued by the Boston Belting Company, 256 Devonshire street, Boston, Mass. It gives a very complete list of the specialties manufactured by this company arranged alphabetically. It is a book that every man should have for reference who has any use for rubber hose, packing and all other rubber goods.

A catalogue and price list for the year 1900 is issued by the Port Chester Bolt & Nut Company, Port Chester, N. Y. It comprises about sixty pages and has a dark green cover printed in gilt. It describes the complete line of bolts and nuts which this company manufactures and gives very complete tables regarding styles, prices, etc. Some attention is also given to the special line of iron work for ship and dock builders and for other such uses, and the company is now establishing a department for doing special work in the line of steam hammer forgings.

"The Work of a Careless Engineer" is the title to an interesting pocket size booklet just issued by the Boyer Sectional Water Tube Boiler Company, 90 Water street, New York city. It describes a very strange accident to a Boyer boiler caused by carelessness on the part of the engineer, it is alleged. Three illustrations are given which show what the result was and in the text it is explained why there was not a very serious loss of life because of the type and construction of this boiler. There is also quite a description of boilers of this type recently installed on steamer *Clara* and a detailed statement is given showing the great advantage to this steamer in changing from the old boilers to the new boilers.

A neat catalogue is issued by the Coatesville Boiler Works, Coatesville, Pa., describing the marine and other boilers manufactured by this company.

Users of varnish will be interested in a very useful souvenir which is being distributed by the David B. Crockett Company, Bridgeport, Conn. It is an aluminum tray for use on desks, for holding pencils, pens, etc.

Compressed air tools manufactured by the Empire Engine & Motor Co., Orangeburg, N. Y., are well illustrated and described in a catalogue now ready for distribution. The catalogue is well printed on coated paper and the tools are illustrated with engravings of considerable size. Among the tools described are drills, reamers, hoists and other tools.

Gas engines, both marine and stationary, manufactured by the Wolverene Motor Works, Grand Rapids, Mich., are fully described in a neat catalogue just issued. These engines range in horse power from the single cylinder, two horse power engine up to the three cylinder, sixty horse power ones. Attention is also given to the launch hulls which this company manufactures.

BUSINESS NOTES.

Marine Paints.—A recent fire destroyed one of the plants in which some of the paints manufactured by George W. Piper, 54 South street, New York city, were stored. Fortunately Mr. Piper had on storage elsewhere a large supply of paints, so that in spite of all reports to the contrary he is able to supply all orders without any delay.

American Stokers.—Now that some of its stokers have been introduced into steamship work and have proven themselves efficient, the American Stoker Company has found it necessary to give more careful attention to marine work, and has organized a special department in this line. Larger quarters have become necessary, and the company has moved to offices in the Bowling Green Building, 11 Broadway, New York.

Durable Wire Rope.—A new style of rope for rigging, hawsers and for other purposes, which is being introduced by the Durable Wire Rope Company, 288 Congress street, Boston, Mass., has met with much success for marine uses. This rope is made of a combination of manila and wire, giving strength, lightness and durability. Many points are claimed over galvanized wire rope, not only because the cost is considerably less, but because this rope is very much more durable and is rust proof and water proof. It can be used in any application where ordinary manila rope can be used, and there is no galvanizing to crack or chip off. A neat pamphlet describing this rope and giving much information about it is sent to all inquirers.

A Good Test for Packing.—The U. S. Army Transport *Thomas* before she sailed from New York last December had metallic packing fitted in her engines by the U. S. Metallic Packing Company, 13th and Noble streets, Philadelphia, Pa. The steamer reached San Francisco March 1, after completing 22,000 miles with forty-eight actual steaming days. Upon reaching port Chief Engineer Arthur G. Rose sent a letter to this company, signed also by the first and second assistants, containing the following statement: "We left New York November 4 for Manila and touched in ports only for coal, arrived at Manila December 23. In Manila, I examined packings ('clearance') and found them scarcely worn and all were replaced as they were. Up to the present time we have had no trouble with hot or leaking piston-rods or valve stems, and less swabbing and oil have been required."

Drop Forgings.—Users of drop forgings of all kinds will be interested in a line of such goods offered by the Springfield Drop Forging Company, Springfield, Mass. This company makes a regular line of wrenches of all kinds and sizes, and it has recently doubled its facilities, so that it is now equipped and especially fitted to do work of all kinds. Among the specialties which it devotes attention to besides wrenches is engine work, such as crank shafts and other parts which require to be carefully made to scale and finish.

Oliver Wood Trimmers.—The American Machinery Co., Grand Rapids, Mich., reports an excellent demand for the Oliver wood trimmers in yacht and shipbuilding establishments of all kinds. These trimmers are made in various styles and sizes. Sheets containing illustrations of the different styles of trimmers and the manner of using them are now ready for distribution. These trimmers are used by most of the leading concerns in the country which have anything to do with wood work.

Berth Mattresses.—A full line of woven wire mattresses and other fittings for steamer berths is manufactured by the Hartford Woven Wire Mattress Company, Hartford, Conn. The mattresses which this company manufactures have stood the test of many years of use and are made to suit all sorts of conditions. This company manufactures the standard style of wooden frames, which has been in use so many years, and has recently offered a line of metal frames for such mattresses made plain or ornamental as desired. These mattresses are in all marketable lengths and widths.

Signal and Alarm Bells.—A neat pocket size catalogue is issued by the E. W. Vanduzen Co., Cincinnati, Ohio, regarding the bells of all types which it manufactures. Each style of bell is illustrated and briefly described. Accompanying this description is a table giving weights and prices. Among the several types of bells referred to are fog bells, which have been extensively introduced on the rivers and lakes as well as on the sea coasts. These are fitted to be placed on cabin roofs or elsewhere. Signal or alarm bells which are suspended by a bracket can be bolted to a mast or side of a cabin, making them very desirable for sailing vessels, yachts, tugs, barges or ferry-boats. Smaller sizes of bells are such as would be used in engine-rooms and on small sailing vessels. A full line of steamboat bells with the sheaves and other fittings is also described.

Mason Improved Steam Pumps.—A detailed description is given in the catalogue recently issued by the Mason Regulator Company, 6 Oliver street, Boston, Mass., of the Mason improved steam pump. In this pump the action of the valves is such as to maintain a continuous motion of the steam piston, thus avoiding what is termed a dead center and rendering the pump absolutely positive in its action. This positive action is brought about in a very novel and ingenious manner. It consists of two ordinary D slide valves, one called the preliminary valve and the other the main and auxiliary valve combined, both working on the valve seat of the main steam cylinder, side by side, and receiving their motion by a yoke, connected to the valve stem by means of a collar and T slot, this yoke sliding in a race-way contained in the steam chest. The duty of the main valve is to alternately admit and exhaust steam to and from the main steam cylinder, in the usual manner, and also to control an auxiliary port. This single auxiliary port, being made common to both ends of the auxiliary cylinder, through the action of the preliminary valve, which acts as a switch, alternately connects the single auxiliary port to either end of the auxiliary cylinder. It will be seen from this that only one active auxiliary port is required, the others being inactive and only serving as passages, thereby permitting one auxiliary port to work in common with either end of the auxiliary cylinder.

A General Supply Company.—Mr. R. F. Manning, who has been well known for several years in the machinery and supply trade in New York, has organized a general supply company at 40 John street, where he will carry a large line of machinery and supplies.

National Automatic Lubricators.—A neatly printed booklet, pocket size, is issued by the National Lubricator Co., 255 Pearl street, Albany, N. Y. The special points claimed for these lubricators are less chances for the glass to break, the large diameter of the glass, no valves to need attention, an automatic device which shuts off pressure immediately should glass break, the replacing and adjustment of the glass with a single adjusting bolt and the cleaning of the glass at any time by the simple turning of a screw.

Correspondence Instruction.—The value of correspondence instruction is shown in the following letter, written to the American School of Correspondence, 156 Tremont street, Boston, Mass., by graduate E. M. Barber, who is chief engineer of the Boston Towboat Company. In this letter Mr. Barber says: "In regard to your school, I would say that it is one of the finest in the country. I can now sit down and figure any of the several strains, which I was unable to do before and can learn the pressure on parts that I did not know."

Feed Water Heaters.—A recent chief engineer of the steamer *China*, plying on the Great Lakes, wrote to Robert Learmonth, 200 Lafayette avenue, Buffalo, N. Y., as follows: "The purifier placed on the boiler of the steamer *China* has proven highly satisfactory. I cleaned the boilers but twice last season, and did not find as much mud as formerly, when cleaned once each month. I consider it of great benefit too, on account of its producing a high temperature to the feed water, causing a more even expansion and contraction on all parts of the boiler."

Three Wheel Pipe Cutters.—The Barnes Tool Company, New Haven, Conn., manufactures eight sizes of three wheel pipe cutters. They can be used for cutting pipes from one-eighth of an inch to twelve inches in diameter. These cutters are not new on the market, having been offered for several years and are now well known. Special care has been given to their manufacture and the especial claim made for the three wheel pipe cutter is that it can be used in corners where single wheel cutters would be useless. This feature makes it also preferable for bench work as it works quicker and more easily, thus saving both time and labor. A very complete catalogue is published by the Barnes Company, giving full details, with illustrations of the several pipe cutters, also the pipe wrenches and other specialties manufactured by the company.

The Faultless Cotton-Felt Mattress.—A mattress especially designed for use on yachts and vessels is being introduced by H. L. Dougherty & Co., 11 North Eleventh street, Philadelphia, Pa. It is called the "Faultless" cotton-felt mattress. It is especially free from the recognized discomfort caused by vermin. This advantage results from the material being purely vegetable and without any animal product, there being thus an absence of animal nutrition. It is particularly well adapted for use on steamers, sailing vessels, and generally on board ships. The price is very low and the mattress itself, so it is claimed, will bear comparison with that of high-priced hair mattresses. The composition is not simply cotton, but cleaned, carded, interlaced cotton-felt, and being non-absorbent will not mildew. The assurance is given that the mattresses will be found to be odorless, always sweet and clean. They will not mat, nor become lumpy, as they are made as perfect as possible by the use of excellent machinery. The manufacturers supply cotton-felt goods, from small cushions to mattresses for entire vessel outfits.

Kirby Lubricators.—In addition to its shipbuilding business, the Detroit Shipbuilding Co., Detroit, Mich., operates a large factory in which it manufactures a line of supplies for marine work, and among these specialties are the Kirby lubricators. A catalogue is devoted to this special subject and gives excellent engravings of the various types of lubricators, with a complete detailed description of each. They include various types of lubricators for engines and pumps, also hand oil pumps.

Thrust Collar Roller Bearings.—Considerable attention is given in the new catalogue issued by the Ball Bearing Co., Watson street, Boston, Mass., to the thrust collar roller bearings now being put on the market. The catalogue states that "they are theoretically wrong, practically right." A large illustration similar to the one in the advertisement of this Company elsewhere shows the construction of the bearings. These bearings have been thoroughly tested in heavy duty for two years and in places where enormous pressures were used beyond the capacity of balls to withstand. In each case the bearing is reported to have given excellent satisfaction. The company furnishes this type of bearing at a reasonable price. When desired these bearings can be furnished without holes in the center, to be used as an end thrust where the shaft rests directly on the bearing. In ordering bearings of this kind it is desirable to give revolutions per minute of the shaft.

Mather Launches and Boats.—A catalogue recently issued by C. B. Mather & Company, Rowley, Mass., in reference to the launches and boats which they build says: "We do not build the cheaper grades and as we use only the best of material we can and do guarantee everything we build, in material, workmanship, finish and durability. As the greater part of our work is done to order, we will make such minor alterations as may be desired at no extra cost. Our modes of construction are the ordinary lap and smooth lap joint, the caulked joint and the smooth batten joint. Although these modes of construction are known all over the country, we wish to call attention to the fact that there is a great deal of difference in the way they are done; that the durability and tightness of the craft relies wholly on their being done properly. We cut every board to fit perfectly, thereby making it unnecessary to steam, warp or spring them into place. All fastenings are copper or brass, unless otherwise stated. As a guide when ordering, we give the kinds of woods we use and their uses. Cedar and cypress are used for planking, as they are the lightest and most durable, and they shrink less than any other known woods. Pine is used for planking, bulkheads, floors, seats, etc. Oak is used for keels, ribs, stems, knees, gunwales, etc. Birch, cherry, ash and oak are used for decks, seats, braces and trimmings. Maple is used for paddles, rudders, grating, etc. Elm is used for ribs only. Spruce is used for spars, masts, oars and paddles. Whitewood is used for bottom boards.

Cork Tiling.—The chief points which recommend cork tiling for use on naval or other vessels, for interior use, are that it is lighter in weight than any other tiling and, in fact, than any other flooring of an equal thickness. It has great wearing qualities, being more durable than carpets, linoleums, rubber matting, and similar floor coverings which are used. It is easily kept clean; is not affected by water, and being the best known insulation is a protection from either heat or cold. It makes a warm floor comfortable for the feet, and for this reason is especially recommended for use in staterooms or other living rooms aboard ship. When properly laid and finished it makes a handsome flooring. For exterior use the same recommendations apply, and in addition it is not slippery and assures a solid foothold, at the same time giving a smooth and level surface. The tiling can be applied to either wood, steel or iron decks. It is offered to the public by The Cork Floor and Tile Co., 17 Milk street, Boston, Mass.

Ross Feed Water Filters.—The feed water filters or oil separators manufactured by the Ross Valve Co., Troy, N. Y., have found a good field in this country, and are being much used on many of the larger steam vessels. They have already made their reputation on many of the transatlantic and other large steamships. The function is to remove oil from feed water wherever a condenser is used. The filter is connected into and forms a part of the feed pipe and is usually located between the feed pump and the boiler. Where fresh water is not readily available, as in marine plants, a filter of this kind is very essential to the steam equipment. The catalogue issued by this company describes the filter quite completely.

An Endorsement From Lloyds.—The Bethlehem Steel Company, 100 Broadway, New York, advises us that it is in receipt of the following letter from the secretary in the London office of Lloyds Register of British and Foreign Shipping: "I have the pleasure to acquaint you that the General Committee at their last meeting to-day have been pleased to decide to include your name on the list of manufacturers who have satisfied the Committee as to their ability to produce steel which will comply with the requirements of the rules of this Society. This decision is subject to all tests with respect to material manufactured by you, for use in the construction of vessels or machinery intended for classification in this Society's Register Book being carried out in accordance with the requirements set forth in the rules and in the presence of a Surveyor to the Society; and also to the records kept at your works of the charges being at all times in such a condition as to admit of each bar or plate being traced to its charge."

A Complete Graphite Business.—According to *Graphite*, the business of the Dixon Crucible Co., Jersey City, N. J., is unique and is the only organization of the kind in the world of this industry. Everything is made of which graphite is an ingredient. Some concerns make pencils, but no crucibles, others make crucibles, but no pencils. Others make graphite paint, but no lubricants, others make lubricants, but no stove polish, and thus through all the ramifications of the graphite industry others make one item solely, while the Dixon concern makes everything under one roof and one management. Pencils, crucibles, lubricants, foundry facings, greases, paints, electric specialties, with all their details, as found in its catalogues. The company digs the ore, cuts the forest down, assembles the raw stock, and completes a hundred and one useful products. The company has an extensive organization stretching far and wide: First, there are the main offices in Jersey City, next the American flake graphite mines at Ticonderoga, N. Y., then control of the product of the Bavarian graphite mines in Austria, then a cedar wood plant in Florida, each place equipped with a large steam plant and elaborate factory equipment. The selling organization is an army of travelers going all over the United States, South America, Europe and Asia, with salesrooms in New York, Philadelphia and San Francisco.

Special Paints.—Charles H. Besly & Co., 10 and 12 North Canal street, Chicago, Ill., report that they are the Western representatives and carry a complete stock of the celebrated Pecora machinery paints, which have been on the market and given excellent satisfaction since 1862. Flat steel color is in paste form for engines, tools and general machinery. Egg shell gloss enamel finishing paint for engine tools and general machinery. This paint is claimed to be dust proof in ten minutes and dries hard in thirty minutes. Dresden machine enamel imparts rich glossy appearance to gas engines. Pecora blow hole cement is something new. It will stand under the planer, lathe, file, and other finishing operations. It is sold dry and is worked with a knife. It stands 200 deg. heat. C. H. Besly & Co.'s new May catalogue is now ready for distribution and is mailed free to any address on application.

Steam Specialties.—The Star Brass Mfg. Co., 108-114 East Dedham street, Boston, Mass., is supplying all of the safety valves, steam cocks, revolution counters, etc., for the two big steamships which the American Line has under construction at Clydebank, Scotland. The Star Brass Mfg. Co. has also furnished valves, stem cocks, etc., for a number of torpedo boats recently under construction for the U. S. Government. The Japanese cruiser *Chitose*, built at the Union Iron Works, San Francisco, Cal., was supplied by this company. A very complete catalogue comprising 168 pages has recently been issued. It shows a very full line of steam specialties of all kinds which this company manufactures. Each specialty is completely described as well as illustrated. In many cases where it is advisable sectional views are given, adding much to the value of the catalogue. There is a very complete line of valves, cocks, indicators, lubricators, and, in short, almost everything and anything that would be looked for in the steam engine department of a vessel. A very complete index adds much to the value of the catalogue.

Many Repeat Orders.—The Burt Mfg. Co., Akron, Ohio, manufacturer of the Cross oil filter, recently entered the twelfth order from the National Steel Co., the twelfth from the American Tin Plate Co., the ninth from the American Steel & Wire Co., the seventh from the Federal Steel Co., the fourth from the Calumet and Hecla Mining Co., and duplicate orders from the Cambria Steel Co., Diamond Match Co. and the National Cash Register Co.

Rotating Gauge Cocks.—The Pittsburgh Gage & Supply Co., 309 Water street, Pittsburgh, Pa., has found much demand for its rotating gauge cocks. These have been on the market for ten years and many thousands of them have been used on the lakes and rivers, as well as on the sea coast. These cocks are self grinding and have a metal stem and seat, require no packing, and it is claimed are absolutely safe from leakage. The cocks are so constructed that when open, steam or water passing through the spiral causes the stem to revolve rapidly, thus cleaning the interior of the cocks, preventing the formation of sediment, and when allowed to come back to its valve seat grinds it clean and true. The spiral is placed near to the valve seat and is protected from the accumulation of sediment or corrosion, and the construction is such that it is impossible for steam or water to pass the spiral without causing the stem to rotate. A lever holds the valve to its seat without interfering with the opening of the cock, or the rotating of steam when the cock is in use.

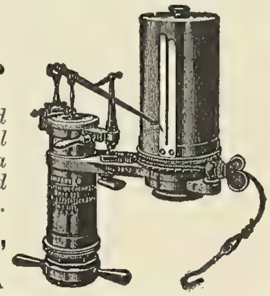
CARBORUNDUM.—Owing to the large expansion in its business the Carborundum Company, which has its factories and headquarters at Niagara Falls, N. Y., has opened an agency in New York city at 136 Liberty street, with Mr. Emil Ulrich as agent.

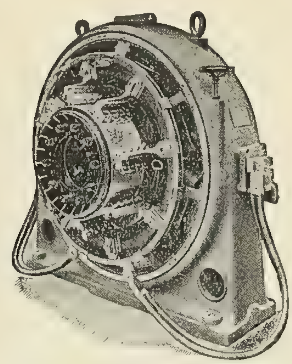
QUICK CLOSING WATER GAUGE.—Many of our readers will be interested in the advertisement elsewhere of Paul B. Huyette, which shows the "P. B. H." Quick Closing Water Gauge—something which should be most acceptable to those who have encountered the difficulties incident to shutting off a water gauge glass which has "let go." A pull of the chain from the boiler room floor closes both bottom and top valve of this gauge at once. The gauge is made of the best steam metal, extra heavy throughout, and is protected by heavy guard rods. The manufacturer, Paul B. Huyette, 1225 Betz Building, Philadelphia, Pa., reports a most excellent demand for these gauges.

"UNION CLOTHING FOR UNION MEN."—This is the business motto of the Hamilton Carhartt Co., manufacturers of the workingmen's over clothes, Detroit, Mich. That this policy has met with success is evidenced by the fact that the company has built up a magnificent trade in every State in the Union and does business in a model establishment, under rules which are used by the union journals to illustrate what may be accomplished by maintaining harmonious relations between capital and labor. The Hamilton Carhartt Co. offers to send a self-measuring tape and illustrated time book free to readers of MARINE ENGINEERING, and to send goods by express where they cannot be obtained from the local dealers.

MARINE PAINTS.—Users of paint of any kind will be interested in a series of sample cards which are sent to all inquirers by Benjamin Moore & Co., 262 Water street, Brooklyn, N. Y. One card gives samples of seven different shades, which are intended especially for ship decks. This paint, the circular states, dries perfectly hard with a gloss in eight hours. Complete instructions regarding the way in which paint is properly applied are printed on the back of this circular. Another card gives eight samples of enamel paints, which this company manufactures. Information regarding these paints, wood stains and other manufactures of the company can be had upon application.

STEEL WOOL.—Steel wool, introduced five or six years ago, is a machine produced material that is used as a substitute for sand paper. It is composed of sharp edged threads of steel, which curl up together like wool. Made in various degrees of coarseness, steel wool is put to a variety of uses, the finer wools for polishing woods and metals and the coarser for rubbing down paint and varnish. It is often used on special parts of work, while, for example, on flat surfaces, a man would use sand paper with a block back of it, for the moulding he would use steel wool, which fits into the crevices and conforms itself to irregular shapes. Such work can be done with steel wool far more readily and quicker than with sand paper; and it is used with like advantage on irregular and small surfaces and on carved work. Besides the steel wool there is a coarser material of the same kind called steel shavings, which is put to various uses, as in taking off old paint and varnish and in polishing wood before painting. Sand paper clogs in use. The wool is commonly used with gloves, to keep the ends from sticking into the fingers. One of the leading manufacturers is the Buehne Steel Wool Co., 15 Dey street, New York.





Down Draft Forges.—The Buffalo Forge Company, Buffalo, N. Y., has had its down draft forge department swamped with orders and has been taxed to keep pace with them. A special catalogue is published, describing and very excellently illustrating the many types of forges which are made. They vary from small and light weight ones, such as would be used on board a small vessel, to the largest and heaviest one built. These down draft forges and furnaces are an important departure in smoke removing. The smoke and gases are immediately drawn away.

Big Windlasses.—The Hyde Windlass Co., Bath, Me., is rushed with orders and is now as much crowded for room as before moving into its present new quarters. The machine shop will have to be enlarged with the addition of the new foundry. Work is to be shipped to England for one of the steamships building there for the American line. These windlasses weigh, crated, 40 tons. They are built to hoist a 3 1-4 in. chain and the main shaft is 12 ft. long, 10 1-2 in. in dia., and weighs 2 tons. The Windlass Company is also building the windlasses for three of the monitors of the Connecticut class building in different parts of the country.

"Little Giant" Pneumatic Tools.—The Standard Pneumatic Tool Company, Marquette Building, Chicago, Ill., reports a surprisingly large demand for its "Little Giant" pneumatic tools. It has recently supplied many shipyards and boiler shops not only in this country, but abroad. The foreign demand was so great that a special company was recently organized in Great Britain to manufacture and handle tools for foreign trade. Tools are sent whenever desired on trial, with the distinct understanding that they can be returned at the manufacturer's expense if they do not give perfect satisfaction. The company keeps them in repair for one year. An excellent circular has recently been issued by this company, illustrating a number of these tools, copies of which will be sent upon inquiry.

Standard Pneumatic Tools.—Owing to the great increase in its business the Standard Pneumatic Tool Company, Marquette Building, Chicago, Ill., has been obliged to increase its facilities in the East, and Mr. George A. Barden, formerly superintendent of the works of this company, has been made Eastern agent, with headquarters at 141 Broadway, New York.

Lubricating Oils.—A neat booklet pocket size regarding the matter of lubricating oils and greases has met with much demand, we are informed by W. J. Schaefer & Co., 33 Barclay street, New York. This company has made a special point of providing oils for marine uses of all kinds. Users of oils will find it worth while to get a copy of this catalogue.

Crumlish Forges.—The Crumlish Forge Co., Buffalo, N. Y., has met with much success among shipbuilders, and now has forges in the leading shipyards of the country. Many testimonials have been received, which are very complimentary, one from Arthur Sewall & Co., Bath, Me., who have recently taken up the building of steel hulls, stating: "We have found your forges very satisfactory; in fact, consider them the best in the market for shipyard use."

Driving Chuck Drills.—To assist in meeting the great demand for positive driving drill chucks, the Pratt Chuck Co., Frankfort, N. Y., has found it necessary to install a new 150 H.P. Corliss engine. The success in the sales department has been almost phenomenal, having, in addition to the large number of orders ahead, daily additions. The company attributes the secret of its success to the fact the chuck permits the drill to be worn out without slipping or defacing the drill numbers, thus saving much time to the machinist.

Norton Ball Bearing Jacks.—The Ordinance Department of the U. S. Army recently made a test at the Watertown Arsenal, Mass., of the ball bearing jacks manufactured by A. O. Norton, 167 Oliver street, Boston, Mass. The report says: "It was a 26-in. jack, 50,400 lbs. were raised by operating the lever. The jack was then removed from the testing machine, examined and found in good working condition. Returned to the testing machine and loaded, increasing the pressure with the machine to 240,000 lbs. total. Nut disabled. Ball bearing in good working condition."

Falls Hollow Staybolts.—The Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio, reports an excellent demand for forged staybolt iron for marine uses not only by the Government, but by many ship and marine boiler builders. These staybolts are guaranteed to meet the strictest requirements. The hole is central and of any size desired, and it extends clear through the entire length of the bolt, making the strength uniform. The end next to the fire box may be left open or closed as desired. As the staybolts are rolled hollow from solid material, they are claimed to be more uniform and flexible than those which are drilled. Samples will be furnished by the manufacturer upon application.

NEW OFFICE BUILDING.—It was in 1894 that the Westinghouse Electric & Manufacturing Company removed from the City of Pittsburg to the site of the present works at East Pittsburg, twelve miles from the city. Last year the works again proved unequal to the expanding demand for Westinghouse electrical apparatus. Recent additions to the works already completed and those now in course of erection will bring the floor space to half a million sq. ft., equal to 11 1-2 acres. About a year ago it was determined to erect the permanent offices, which should be of sufficient size to afford accommodation for the staff of the numerous departments of the business. The architectural features and the general arrangement have been under the supervision of Mr. George Westinghouse. The dimensions are 250 ft., with a depth of 50 ft., with seven stories. The entire building is fireproof. The floors and partitions are of terra cotta, the former built with arches, above which are mud sills bedded in concrete. The Mosaic and wood floorings rest upon the beams and sills, and as the intervening space is filled with concrete the sound from one floor to the other is thoroughly deadened. The roof has a very high pitch, and is constructed entirely of steel trusses, to which the slate is fastened with copper nails. At the ends of the building and in the center Gothic gables and dormer windows in the roof, add greatly to the attractiveness of the outline. The partitions between the offices are of terra cotta covered with adamant plaster. The visitors to these offices will find the very latest improvements of the architect and the engineer, in the heating, lighting and ventilating arrangements, and also in the pneumatic dispatch and telephonic systems. The total number of employees at the works is close to 5,500. Mounting on one of the elevators to the mezzanine floor, one enters the works' office. Upon either side of the central passage are offices devoted to the Superintendent, Engineer of Works, the Construction Department and the Production Department. A novel feature has been introduced by devoting one entire end of the building to fireproof vaults. Twenty-four ft. from the outer walls, a fireproof brick wall is carried upwards from the foundation to the roof, forming fireproof vaults upon the several floors, each having an area of 1,200 sq. ft. Entrance to these six vaults is through two sets of double fireproof iron doors on each floor. The vaults are for the safe custody of the valuable plans and blue prints of electrical machinery, the general books and records of the company, and for the large collection of negatives, photographs and electrotypes. Upon the second floor near the elevator is a handsome reception room for visitors, and to the right a door opens upon a suite of rooms devoted to the Managers and their assistants, including rooms for the President, Vice-President, Acting Vice-President, the Manager of the Works, and for his clerical staff. The arrangement of the third floor is similar to that of the second. The suite of offices to the right are occupied by the Westinghouse Company's Publishing Department and the Purchasing Agent and his staff. The arrangement of the fourth floor differs from those below and the entire floor is occupied by the Mechanical Engineering Department and by the draftsmen. The fifth floor is similar to the fourth and the Electrical Engineers are housed there. Upon the sixth floor are two dining rooms, handsomely wainscoted with mahogany, the upper walls being tinted. Adjoining them is the butler's pantry and ample kitchen. One of the rooms of this floor forms the "Central" for the telephonic system, and another serves as a dining room for the women stenographers. Probably the most novel feature of the improvements is the system of pneumatic tubes, whereby all works departments and all the offices are connected through a central exchange station. All the mail and other matters are thus distributed in very much shorter time than could be delivered by messengers.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

NEW OFFICES.—Owing to the demand for larger office facilities for eastern headquarters, the Chicago Pneumatic Tool Company has moved from 122 Liberty street to 95 Liberty street. The offices, as heretofore, will be in charge of Mr. Thomas Aldcorn.

ECONOMY LUBRICATOR FILLER.—The Monash Company, 203 South Canal St., Chicago, Ill., is introducing the Economy lubricator filler. It is believed to be a great oil and time saver. Anybody can connect it to the lubricator. It only requires to be fitted exactly and as it rests easily on the steam joint it prevents any possibility of spilling the oil. Another important thing is that it does away with the difficult task of filling lubricators by hand. A circular describing this device is now being distributed.

REAMERS.—The Philadelphia Pneumatic Tool Company, 21 South 12th street, Philadelphia, Pa., is offering a special line of reamers, which are made for use in connection with the pneumatic tools which this company makes. These reamers are designed especially for the exacting services required in shipyards, boiler shops, etc. They are made of a special grade of steel, each carefully machined and tempered. Each reamer is thoroughly inspected and fully guaranteed and any that are deficient in material or workmanship can be returned. They are made in all sizes.

"Peerless"

LARGEST MANUFACTURERS IN THE WORLD OF

FINE FLANGE, PISTON and VALVE ROD PACKINGS.

Rainbow Packing.

Thousands of Imitators. No Equal. Will Hold Highest Pressure.

Don't have to use wire and cloth to hold Rainbow. Can't blow it out.

The Color of Rainbow Packing is Red.

Three Rows of Diamonds extending throughout the entire length of each and every roll of Rainbow Packing.

Peerless Spiral Piston and Valve Rod Packing

It will hold 400 lbs. of steam. Will run twelve months in high speed engines.

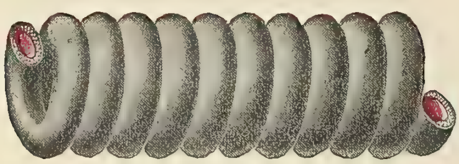
The Eclipse Sectional Rainbow Gasket.

⅜ in., ½ in., ⅝ in. for Hand Holes.

¾ in., ⅞ in., 1 in. For Extra Large Joints.

Fac-Simile of a 6-inch Section of Eclipse Gasket.
Showing Name and Trade-Mark imbedded.

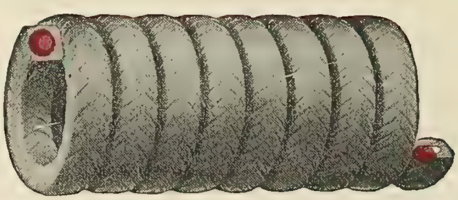
Hercules Combination



METALLIC STOP VALVE PACKING.

Keeps the stem absolutely clean. Always tight. Put up in boxes.

Honest John.



HYDRAULIC RAINBOW CORE PACKING.

For Water and Hydraulics. Made both straight and spiral.

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THE PEERLESS RUBBER MANUFACTURING COMPANY,

16-24 Woodward Avenue, DETROIT, MICH. 202-210 S. Water Street, CHICAGO, ILL.
7-19 Beale Street, and 18-24 Main Street, SAN FRANCISCO, CAL.

16 WARREN STREET, NEW YORK.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

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GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
1616 La Fayette St., Alameda, Cal.

GEO. A. GRUBB, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

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JOHN MCG. STERRITT, 129 Broad St.,	New York, N. Y.
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This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St , Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN MCCLURE, 54 High St., E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 3111 Dillon St., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St., Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS, Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD MCMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. MCCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, FRANK H. GOODELL, 406 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOFF, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 12 St. Joseph St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta., Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, CHAS. W. ROBINSON, McGill Building, Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H. BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

The Keystone Drop Forge Works, Twentieth and Clearfield streets, Philadelphia, Pa., show a very complete line of drop forgings of all kinds in the catalogue for 1900, just issued. This catalogue comprises 20 pages, with many illustrations, and among the specialties manufactured are connecting rods, washers, valves, shafting, keys, bits of every kind, collars, hoist hooks and a very complete line of wrenches, etc.

Sturtevant electric fans, which were described in a recent bulletin, proved such an attractive edition, that the third edition has just been issued as Bulletin H. It comprises 8 pages 8 by 10 in. in size, is very handsomely printed and exceptionally well illustrated. A great many types of fans are shown, and the illustrations are large, so that the detail is made very plain. Enough reading matter accompanies the illustrations to make them easily understood. Those of our readers who did not secure a copy of the previous editions of this bulletin, can now undoubtedly be accommodated.

Vertical duplex boiler feed pumps. together with several other types of pumps, condensers, air compressors and other specialties manufactured by the Dean Bros.' Steam Pump Works, Indianapolis, Ind., have a pocket size catalogue of 16 pages devoted to them. The cuts are nearly all of them full page size, and these, in connection with the sectional views, make the catalogue quite complete. Several tables of sizes and capacities are given, and there is other information which should make the catalogue of much value to our readers.

Those of our readers interested in Alco vapor and similar launches should send for a copy of the catalogue just issued by the Marine Engine Co., Harrison (Newark), N. J. It comprises 40 pages, 6 by 9 in. in size. Launches of many types are illustrated and a number of pictures are shown of the new works which this company has recently established, making it one of the most complete yacht building shops in the country. There is also quite a detailed description of the Alco vapor engine, with its special advantages; in short, there is a great deal of mattter that any user of a launch would be anxious to have. Copies of the catalogue can be had from the company by addressing it and enclosing 10 cents.

The 1900 catalogue of steam specialties manufactured by the Watson & McDaniel Co., 146 North Seventh street, Philadelphia, Pa., is now ready for distribution. It is more of an illustrated price list than a complete catalogue, but the good quality of the illustrations shows the construction and manner of working of the several specialties and each one is concisely and fully enough described for all ordinary uses. Among the specialties which will be of interest to our readers is the new diaphragm reducing valve; also the Watson pressure regulator, the Jennings steam separator, both horizontal and vertical, and the duplex valve, which is one of the most popular specialties which this company is pushing.

"Benedict-Nickel" seamless tubing is one of the newer specialties of the Benedict & Burnham Mfg. Co., Waterbury, Conn., and in order to fully explain the many features of this tubing, the company has issued a very neat hand-book, which is well illustrated, and gives, within its seventy odd pages, much valuable information regarding this metal and the many other specialties manufactured by this company. As shown in the illustrations this tubing is particularly desirable for marine use, not only for railings, but for condenser tubes, as it is believed to thoroughly resist corrosive action. Unlike the nickel-plated tubing, this is made of white metal clear through. A great deal of valuable information regarding this subject is well brought out in this booklet.

The 12,365 packings and where they are being used, being the output for 1899, is told in a 12 page booklet, with cover, just issued by the U. S. Metallic Packing Co., Thirteenth and Noble streets, Philadelphia, Pa. Three fine engravings show two classes of the packing and the "ideal method of lubricating packings." A perusal of the list of purchasers, and the vessels referred to, shows that many of the leading vessels built during the past year were supplied with these packings, and in a number of instances, vessels already in use adopted them. The booklet is now ready for distribution.

The catalogue just issued by the Standard Tool Co., Cleveland, Ohio, is bound in a double cover and the name of the company is daintily and neatly printed in gold in a little shield. The reading matter is printed in English, French and German. The 24 pages comprising the text are very thoroughly illustrated with fine wood engravings, and the various manufactures of the company are illustrated, including drills, reamers, chucks, sockets, taps, keys, milling cutters and such tools. Every reader who has use for any of these goods will find a copy of this catalogue a very desirable acquisition for purposes of reference.

Many steam specialties manufactured by the Eynon-Evans Mfg. Co., Fifteenth and Clearfield streets, Philadelphia, Pa., are very fully and completely described in a catalogue of 128 pages, just issued. The catalogue opens with the guarantee which goes with all of the goods sold, "Thorough satisfaction to the consumer, or money refunded." Four pages are devoted to a very complete index, then follows the catalogue proper. This includes a reference to the bronze foundry of this company, which has a capacity of making castings from one ounce to 9,000 lbs. The first specialty referred to of particular interest to the marine field is the Korting type of injector, which has recently been modified, so that it is now started, regulated and stopped with one handle. Several other improvements are also referred to. Considerable attention is given to the Eynon-Korting compound injector and a number of illustrations show, not only the outward appearance, but the construction of these injectors. Many pages are given to the subject of condensers, which are shown in many styles by large and excellent illustrations. A number of pages are devoted to steam jet apparatus and blowers of several kinds. A number of illustrations show the application of the exhauster to engines and centrifugal pumps. In a similar manner the application of steam jet pumps as applied to steam vessels is shown. The latter part of the catalogue is devoted to valves of various types and sizes, including globe and gate valves for all uses, regulating valves, brass unions and steam traps. The steam trap has already been given the thorough test of years in marine use. Altogether, the catalogue is a very handsome one, printed in two colors and bound in heavy green paper, with gilt lettering.

Users of gasoline engines will be interested in a folder just issued by the Lowell Model Co., Lowell, Mass., describing the gasoline engines with propellers, manufactured by this company. The several types of engines are illustrated and much information is given regarding them.

"Mechanical Ventilation and Heating by a Forced Circulation of Warm Air," is the title of a lecture recently delivered by Walter B. Snow, of the engineering force of the B. F. Sturtevant Co., Jamaica Plain, Mass. This lecture has been very handsomely printed in pamphlet form by the Sturtevant Co. It comprises 31 pages, and is very fully illustrated with a number of illustrations, showing the manner in which large factories, schools and other buildings are ventilated and heated, and full detail of manner of installing the heating apparatus, together with the appliances used, is given. The lecture will prove of much interest to any of our readers who care to investigate this subject.

Large Pump Order.—The order for a pump outfit for stone dry-dock No. 1 in the Brooklyn Navy Yard, was recently awarded to the Prindle Engineering Co., 120 Liberty street, New York, for $40,000.

Counting machines manufactured by the Veeder Mfg. Co., Hartford, Conn., are briefly described in a neatly printed and attractive booklet, 2 1-2 by 3 in. in size. As these revolution counters are very compact and small in size, the neatness of the booklet is accounted for. The cuts show the counters full size. The different types manufactured are shown, including both single and double counters, as well as the rotary and oscillating counters. Every engineer will be interested to have a copy of this tiny book, especially as the counters themselves are sold at a price within the reach of everybody.

Refrigeration is a subject of interest to most engineers, but is one about which comparatively little has been written. Because of this, many of our readers will undoubtedly want a copy of a very complete catalogue, which has been issued by the Frick Co., 39 Cortlandt street, New York. The catalogue is 6x9 in. in size, and comprises nearly 150 pages. It is very fully illustrated with a most excellent quality of engravings, and a great deal of information is given on the subject of refrigeration. The company manufactures machines of smaller sizes, with a capacity of from one ton upwards, specially designed for marine uses.

The Bethlehem Steel Co., 100 Broadway, New York, has just issued a booklet of much interest, comprising over 100 pages, giving much attention to the business of this company. The works are illustrated and concisely described. A number of pictures and text tell of the mines in Cuba, where much of the ore used comes from, and attention is given to furnaces of different types. The pictures illustrate in a progressive way the manner in which armor plate and marine forgings of all kinds and similar specialties are manufactured. We understand that copies of this are ready for distribution to all readers of MARINE ENGINEERING who wish them.

Two bulletins have just been issued by the Bullock Electric Manufacturing Co., Cincinnati, Ohio. One of them, Bulletin No. 36, is devoted to marine lighting and power sets. It comprises 12 pages. On the first page is the picture of a Bullock generator direct connected to a Forbes engine. On three subsequent pages are complete detailed descriptions of the generators and the various parts. On the following page are two very fine illustrations of yachts upon which Bullock plants have been installed. The following pages contain a picture of a Bullock generator connected to a Case Engine, together with tables of sizes, dimension sheets, sectional views, etc. The other bulletin is somewhat larger, and is devoted to railway light and power generators. The illustrations are very excellent and numerous. The plants referred to are of considerable larger size than those in the other bulletin.

BUSINESS NOTES.

Marine Paints.—George W. Piper, 54 South street, New York, carries on a large business devoted exclusively to marine paint of all kinds. He is the sole selling agent for the United States of the well-known McInnes English Composition. He also manufactures and imports a full line of enamel paints of all kinds, and carries these in stock for prompt delivery. Sample cards of paints are sent to all users upon request.

Faultless Mattresses.—The H. L. Dougherty Co., 11 North Eleventh street, Philadelphia, Pa., reports that its cotton felt mattresses and cushions have proved very satisfactory in marine work, both for yachts and large merchant vessels. Many special features are claimed for this mattress, because of the absence of animal fiber. One feature that is very important is, that it can be used in case of emergency for life preservers.

"Hub" Thrust Collar Bearings.—The catalogue recently issued by the Ball Bearing Co., Watson street, Boston, Mass., contains an excellent illustration and description of the "Hub" patent thrust collar bearing. These bearings have been very much used where an excessive thrust is developed by a worm and gear. They have been extensively used in centrifugal pumps and propeller shafts. An accompanying table shows the various sizes and prices.

Steam Separators.—The Keystone Steam Separator has met with much success in marine work. It is manufactured by the Keystone Engine & Machine Works, Fifth and Buttonwood streets, Philadelphia, Pa. This separator is made ready to apply, including standard pipe, flanges, water gauge, etc. Steam is admitted from either a horizontal or vertical connection, and takes a downward course through outlets of ample size to admit of passage without back pressure. Considerable more detail is given in a circular which the company issues.

The Peerless Rubber Factory.—For several years there has been a steady growth in the business of the Peerless Rubber Mfg. Co., until now the limit has been reached, overtime work, or two shifts of workmen not being able to keep up with the orders. The company has, therefore, broken ground for a large addition to its plant, and will now be able to turn out promptly larger quantities of its well-known Rainbow packing and other rubber specialties. This company has recently issued a very complete catalogue of all of its goods, copies of which can be had by addressing the Peerless Rubber Mfg. Co., 16 Warren street, New York.

Durable Wire Rope.—An unexpectedly great increase in its business has made it necessary for the Durable Wire Rope Co. to remove its offices to much more commodious quarters at 288 Congress street, Boston, Mass. The peculiar features of this rope have made themselves felt, not only among yachtsmen, but shipbuilders, and have led to the great expansion in business. This rope is claimed to be the strongest, most flexible, most durable and rust proof. The important feature of this rope is that it has the wearing qualities of manila rope, and the strength of wire rope.

Grinding Machines.—The Landis Tool Co., Waynesboro, Pa., makes a specialty of grinding machines for cylindrical, conical and plane surfaces. A catalogue recently issued by this company explains the advantage of grinding machines in working out rough finished shafts and the manner of grinding them, so that when carefully gauged, they shall be accurate in every particular. By the use of these machines one is enabled to use hardened spindles, crank and crosshead pins and other such important parts of engines and steam appliances, where otherwise it might be necessary to use a softer steel. Any of our readers who are at all interested in the subject of grinding machines, will find the catalogue of this company a very valuable one for reference.

Hollow Staybolts.—We are informed by the Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio, that owing to the great amount of time saved by using its hollow staybolts, many boiler manufacturers are discontinuing the drilling of staybolt iron themselves and making use of the staybolt iron manufactured by this company, owing to the great economy.

"Cuts Like a Diamond."—Patterson, Gottfried & Hunter, 150 Centre street, New York, are making a specialty of the Sterling hack saw blades. The claim is made for this blade that it "cuts like a diamond." They are made in standard sizes, and when desired saw frames are sold with them. The company issues a little folder, giving considerable information regarding these blades.

The Puritan Accident.—A month ago the Fall River liner *Puritan* met with a serious accident while on one of her trips, caused by the breaking of the wrought iron shaft. Order was at once given to the Bethlehem Steel Co., 100 Broadway, New York, to replace this shaft with one of its well-known hollow forged steel ones. In several instances of this kind the Bethlehem Co. has been much gratified to have orders promptly placed for one of its hollow forged shafts to replace iron ones which have given out. Among other orders recently received by the Bethlehem Co. is an important one from Australia, for crank shaft forgings.

Rust Preventive.—Charles H. Besly & Co., 10 North Canal street, Chicago, Ill., report an unusually large demand for Mannocitin, which is claimed to be an absolute rust preventive for engines, machinery, tools, and any other metal. Mannocitin is composed of greases and volatile oils. It is, and remains, absolutely neutral, and contains no acid. On application, the oils evaporate, leaving an airtight film or skin, which adheres tightly to the metal, and absolutely and permanently prevents rust and corrosion. Mannocitin withstands salt air, salt water, rain, snow, dampness, perspiration, steam, gases and fumes of acids and ammonia. A booklet is sent to all inquirers, giving much more detail concerning this compound.

Pneumatic Specialties.—F. G. Street, Temple Court Building, Chicago, Ill., is making a specialty of pneumatic goods. Among these are the Climax armor house coupling, a particularly desirable device when hose is used for compressed air. It is easily made use of, and can be applied to any hose. It is especially recommended for use with the flexible metallc hose armor sold by Mr. Street. By use of this armor, hose is made capable of withstanding enormous pressures, and it greatly increases the life of rubber hose. When hose is so protected, it will not kink, nor is it liable to burst. The Climax marine reducing valve is designed to be equally as useful in controlling steam as in controlling air. The special claim for this valve is that it has no diaphragm to break, no stuffing box to be packed, and the dash pot is above the flow of steam.

Olympia Asbesto-Metallic Goods.—The C. W. Trainer Mfg. Co., 89 and 91 Pearl street, Boston, Mass., is offering a line of specialties manufactured from its well-known asbesto-metallic material. Among them are the following: Woven tape, by which joints can be quickly made and which will resist the highest pressure. This is made to all thicknesses and widths, and to suit all conditions. Woven gaskets, which are made in given sizes and shapes, from the asbesto-metallic sheeting. Piston packing, which is suitable for either high or low pressure, and it is made in different shapes and forms to suit all conditions. In order to understand the special features of these goods, it should be borne in mind that a fine brass wire is spun into the warp and weft of the material, giving greater tensile strength and to enable thin material to be used. Elasticity is imparted by a coating of India rubber solution, which renders the fabric waterproof. It is claimed for the Olympia Asbesto-metallic products that they will stand the highest pressure.

FOSTER STEAM SPECIALTIES.—Owing to the great increase in its business, the Foster Engineering Co., Newark, N. J., will erect at once a three-story building. This company started business in a small room in New York about ten years ago, and later moved to its present quarters in Newark. This company has made a specialty of regulators for steam pressure, and has done work not only for the United States Navy, but for the Danish, Japanese, Brazilian and other foreign navies, in addition to merchant marine work.

LUBRICATOR FILLER.—A new invention is the "Economy" lubricator filler, a device patented by the Monash Co., 203 South Canal street, Chicago, Ill. There is no machinery about it, and any engineer can connect it to the lubricator. It rests on the engine, which keeps the oil warm, and it is filled once a week. It does away with the very disagreeable task of filling the lubricator by hand, and reduces the oil bill. as it absolutely stops waste of the most expensive oil used. It is claimed by this method that a pint lubricator can be filled in ten seconds with no labor required. It insures perfect lubrication to the engine, to say nothing of cleanliness. Its operation is very simple.

NEW CLEANSER AND DISINFECTANT.—"Sultar" is the name of a new antiseptic cleanser and disinfectant, which is being put on the market by the Sultar Co., 356 West Fifty-eighth street, New York. It is sold in liquid form for cleansing purposes, for decks, as well as walls on board vessels. It is believed to be positively free from germ life, at the same time purifying the air in a room in which it is used. It is always ready for use, and has been adopted on many lines, such as the American Line, Red Star Line, Anchor Line and Mallory Line. It has such great strength that only a small quantity is used in proportion to the water. A special advantage is the way in which it cuts grease and oil. Sample bottles are sent to all inquirers.

THE McMULLIN MOTIVE POWER CO.—Owing to the enlargement of its scope, the former firm of F. R. McMullin Mfg. Co., has been incorporated as the McMullin Motive Power & Construction Co. The company will devote itself exclusively to the manufacture of gas and gasoline engines and motor vehicles. The executive offices will hereafter be in the Royal Insurance Building, Chicago, Ill.

SHIP BOLTS AND RIVETS.—The Hoopes & Townsend Co., 1330 Buttonwood street, Philadelphia, Pa., manufactures a full line of ship, boiler and cooper's rivets, cold punched nuts, turnbuckles and a number of other similar specialties, which are extensively used in marine work. This company appreciates the tendency of the times toward shipbuilding, and is now making a specialty of goods of this kind.

JONES UNDER FEED STOKER.—One of the newest stokers on the market is the Jones under feed stoker, manufactured by the Under Feed Stoker Co. of America, with head offices at 218 La Salle street, Chicago, Ill. These stokers are designed not only to do away with the smoke nuisance, but to reduce the matter of stoking to a mechanical operation. Their value for marine use can readily be learned by sending for copies of the catalogue and other circulars issued by the company.

DUNDON WATER TUBE BOILER.—Among the water tube boilers recently put on the market, is one designed and manufactured by P. F. Dundon, 223 Folsom street, San Francisco, Cal. Circulars illustrating and describing this boiler are now ready for distribution. They give end views and sectional views of the side elevation, showing the arrangement of the tubes, also a complete boiler. End holes offer easy access to the tubes for the purpose of cleaning, and this is readily accomplished, as the tubes are straight. Any of our readers interested in the subject can secure copies of these circulars.

THE HARLAN & HOLLINGSWORTH YARD.—The Harlan & Hollingsworth Co., Wilmington, Del., successfully launched last month from one set of ways three tugs for the Pennsylvania Railroad Co., the *Wilmington, Johnstown* and *Harrisburg*, in the space of 17 minutes from the time the first wedge was driven till the last boat struck the water. The dimensions of these boats are 100 ft. length over all; beam molded, 22 ft.; depth, 12 ft. 2 in. House on deck partitioned off to form galley, boiler room, crew's water closet, engine room and cabin; also an upper deck, with pilot house, skylight, companionways, etc. Engine, compound, 20 in. by 40 in., 26 in. stroke, supplied with steam by two Almy water-tube boilers. The other work in this yard is progressing rapidly. The steamer *Whitney*, for the Metropolitan S. S. Co., will be launched shortly. The *Manna-hata*, launched in April for the New York & Baltimore Transportation Line, has been delivered, and the barges for the Rockland & Rockport Lime Co. are being rapidly erected. The new 400 ft. ship, the first of three for the Mallory Line, will be laid down on the ways just vacated by the tugs.

Bonar Steam Specialties.—Owing to the great increase in trade with their steam specialties, James Bonar & Co., Carnegie Building, Pittsburgh, Pa., have secured the services of Mr. Thomas R. Davis, who has been well known for many years in the steam specialty trade. Mr. Davis will devote himself to pushing the sale of Bonar oil filters, Bonar gauge cocks, Pittsburgh, feed water heaters and other goods.

Chapman Valves.—The Chapman Valve Mfg. Co., Indian Orchard, Mass., reports the following recent orders in various lines: 243 bronze gate valves, of both medium and heavy weight, from 3-4 in. to 17 in. in size for the United States vessels *Missouri, Arkansas, Indiana, Illinois, Massachusetts* and *Cincinnati*, 64 8 in. and 18 16 in. special iron body valves, with bronze mountings, for the new floating dry-dock at valves are made of high quality of steam bronze valves, with bronze mountings, for the Newport News S. B. & D. D. Co.'s dry-dock. The valves are all of the double-faced solid wedge plug type. The bronze valves are made of high quality of steam bronze throughout. The great majority are made with flange ends and indicating device, and a number are provided with gearing or special operating device. They are to be used for steam, air, water, etc. Many of the dry dock valves are equipped with floor-stand extension rod and wheel for operating from deck above. In other lines of interest to our readers, are 2 50 in. and 3 40 in. straight valves, and 4 24 in. angle valves, with cast iron bodies, full bronze mountings and special babbitt metal seats and gearing for exhaust and condenser piping. These were furnished to prominent electric light and street railway companies. Also, 48 32 in. and 16 30-in. special air valves for blast furnace work. These are for some of the largest blast furnaces in this country. On the first of the year this company issued a new and very complete catalogue and price list. It has had an unusual demand for this book, particularly from consulting and designing engineers in all lines, so much that a new issue is being contemplated.

Smooth-On.—This substance is a metallic putty, and is especially adapted for closing cracks in boilers, putting on patches and such other work where metal surfaces are to be brought together to form a solid piece. It is a dry, powdered composition, when mixed with water to the consistency of a stiff putty, becomes hard and of much the same consistency as iron, so that it can be finished with a smooth surface. It will withstand heat and vibrations, and is affected by heat and cold the same as iron. It increases in bulk when unconfined about 5 per cent when it hardens, and this action is what makes it perfectly tight when confined between two iron surfaces or in an opening or fracture. By remembering this action the engineer in the use of this compound can utilize it in many ways in repairs in cast and wrought iron work, and on account of its strength to withstand heat and vibrations. In ship engine and boiler building plants, there is a demand for a material that may readily be applied in the form of patches, where fractures occur, and also in the case of boilers and piping for permanent joints, mainstay braces and screw nuts. The discovery and use of Smooth-On compound has met with success, and has made easy many repairs that it would be difficult, if not impossible, to do otherwise. As one example of what this material has accomplished on repair work; a large rotary hydraulic pump, with a capacity of seven million gallons per day, collapsed with a fracture 14 feet in length, extending from the discharge pipe around the housing of the pump wheel, to the intake pipe. New castings could not be procured under four months. This pump was repaired with the Smooth-On compound in a few days, and the pump was used at the same speed and capacity as ever. The manufacture of this material is under the supervision of an analytical chemist, who is an expert in iron analysis. Further particulars can be obtained from the Smooth-On Mfg. Co., 547-549 Communipaw avenue, Jersey City, N. J.

An Interesting Launching—One of the largest tugs ever constructed in the port of Baltimore is the John K. Cowen, which was launched a month ago in the yard of the Spedden Shipbuilding Co., Baltimore, Md. The launching was a great success in every way and was witnessed by many hundreds of people.

Cross Oil Filters.—The new power plant of the Electric Street Railway Co., in the City of Mexico, is believed to be the finest in that Republic. It is fitted throughout with American machinery, and among the most recent orders placed was one for Cross oil filters, given to the Burt Mfg. Co., Akron, Ohio.

Interior Decorations.—Hale & Amory, architects, Boston, Mass., announce that they have established a department for the designing of joiner work and interior decoration of yachts and steamships, with a branch under the direction of Mr. Henry G. Morse, Jr., with offices at Drexel Building, Philadelphia.

Coaling at Sea.—The test recently made of the Miller apparatus for coaling vessels at sea has attracted much attention. It is manufactured by the Lidgerwood Mfg. Co., 96 Liberty street, New York. Several foreign governments have investigated this system carefully, and it has now been perfected to such an extent that the Lidgerwood Co. is prepared to fill orders.

Silica-Graphite Paint.—Among the many specialties of the Joseph Dixon Crucible Co., Jersey City, N. J., is the Silica-graphite paint, which is especially valuable for protecting steel and other metal surfaces. An interesting four-page folder is sent to all inquirers, showing two large office buildings in New York, the steel structures of which were protected with this paint before the outside walls were built up.

Moved to South Street.—In order to be nearer the center of his trade, C. A. Geissler, who has recently taken the business so long carried on by H. H. Heinrich in dealing in marine chronometers and fine watches, has moved to 26 South street, New York. In the new quarters Mr. Geissler has better facilities for carrying a regular stock and for giving even greater care and attention to chronometers and watches left in his care for repair and adjustment.

A Growing Shipbuilding Firm.—In 1894, Percy & Small started in Bath, Me., in a small way, in the shipbuilding business. They have evidently prospered from the first, as they have found it necessary to lease within the past month what is known as the Reed yard, in order to build a five-masted schooner just ordered. This is the second time that this firm has found it necessary to enlarge its capacity by leasing other yards. It now has three separate yards in operation, and has a number of schooners under operation, one a six-master.

Electrical Instruction.—Railway Motor Engineering is a new course of instruction offered by the International Correspondence Schools, Box 1111, Scranton, Pa. The course was prepared and is being kept up to date by Eugene C. Parham, Superintendent of the Nassau Division of the Brooklyn Rapid Transit. It is intended for operators, and those who wish to become operators of electrical machinery. As instruction is carried on by mail, it affords a means of acquiring valuable information without obliging students to lose time from work. The International Correspondence Schools were established in 1891, and have nearly 100 courses and over 165,000 students and graduates.

Electric Bells.—Those of our readers who are at all interested in the subject of electric and electromechanical signals, will find a very interesting catalogue on the subject, known as Catalogue No. 37, issued by the Holtzer-Cabot Electric Co., Brookline, Mass. This comprises a full line from the little push button buzzer to gongs of considerable size for fire alarm systems and such uses.

PROFESSIONAL CARDS.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
1616 La Fayette St , Alameda, Cal.

GEO. A. GRUBB, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

ED. R. BLANCHARD, National Treasurer,
583 Fort St. E., Detroit, Mich.

ADVISORY BOARD.

JOSEPH BROOKS, 6323 Dicks Ave.,	Philadelphia, Pa.
JOHN McG. STERRITT, 129 Broad St.,	New York, N. Y.
JAMES H. TAYLOR, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St , Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN McCLURE, 54 High St., E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 418S. Patterson Park Ave., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St.. Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS, Tompkinsville. S. I.. New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble. Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M. MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W. Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S. Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg. N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta., Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563. So. Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H. BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

Patterson, Gottfried & Hunter, Ltd., 146 Center St., New York, send to all inquirers a lithographed card representing an old colored man, who has in his hands a sign showing the different specialties which this company sells, including manila and wire rope, brass and copper goods, and many other specialties which are used in the marine field.

Pneumatic Tools manufactured by the Q. & C. Co., Chicago, are described in one of the most complete catalogues we have seen devoted to this subject. The tools include a full line for all purposes, such as chipping, caulking, beading, riveting, drilling, wood boring, flue rolling, hoisting, etc. The illustrations are very numerous, showing the complete construction of the tools. The text is complete and very concise. Many pages are devoted to rivets of all types, and the illustrations are most excellent. Any one who is interested in the use of pneumatic tools should have a copy of this catalogue.

Special types of boilers manufactured by the Fitzgibbons Boiler Co., Oswego, N. Y., are described and most thoroughly illustrated in a handsome catalogue 9×12 in. in size. The cover is a dark green, heavy paper, printed in gilt, and the text is printed in black and red, on heavy, coated paper.A number of excellent half-tone engravings show the several types, and a number of sizes of this well-known boiler, and a large sectional views in connection with the very complete descriptive matter, makes the catalogue of much value. Copies can undoubtedly be had by writing to the company and mentioning MARINE ENGINEERING.

The Subject of Stoking is one that probably interests every reader of MARINE ENGINEERING, and will undoubtedly result in most of them sending for a copy of the very complete catalogue and book devoted to this subject, issued by the Underfeed Stoker Co. of America, 218 LaSalle St., Chicago. The catalogue is 6×9 in. in size, and comprises 88 pages. It is bound in a handsome cover printed in two colors, and the text is printed in red and black, and is accompanied by many full-page illustrations. These illustrations are very complete views of the stoker under various conditions, and the text gives much information regarding the applications of the stoker to marine and all other types of boilers. A number of tables are given of tests which have been made of these stokers. Many testimonials are also given from users of the stokers, some of which have been in use a number of years. Copies of the catalogue can undoubtedly be had by mentioning MARINE ENGINEERING.

The 1900 Catalogue, issued by the Pedrick & Ayer Co., 85 Liberty street, New York, is now ready for distribution. It is 6×8 in. in size, printed on good paper, and comprises 126 pages of text and illustrations. It is something more than an ordinary catalogue, because of its completeness, and several new tools are shown which have been put on the market since the former catalogue was printed. This is especially true in the very complete line of pneumatic hoists. To other lines of tools, especially riveters, this company has given much attention. The company manufactures practically everything, from small air compressors to the largest tools used in connection with compressed air. The various types of cranes are fully illustrated, as are also the compressors, and detailed information accompanies the many pictures and sectional drawings of the pneumatic riveting machines, to which many pages are devoted. These include both stationary and portable riveters. On page 76 the subject of ship riveting is graphically illustrated. The milling machines, portable crank pin machine, portable cylinder boring machines, also flue-cleaning machines and fuel welding machines, pneumatic tube swaging machines are fully illustrated and described. The very complete index adds much to the value of the catalogue.

A combined pocket and memorandum book is issued by the Charleston Metallic Packing Co., Charleston, S. C., as a compliment to all of those engineers who are users of this company's semi-bronze packing. Those engineers who have not already received a copy can secure one either from the Charleston, S. C., office or the New England branch at 32 Oliver street, Boston, Mass.

Metal sawing machines which the Q. & C. Co., Chicago, manufactures, are fuly described in a catalogue just issued. There are a number of illustrations, with sufficient text to fully describe the several machines. These include cold metal sawing machines of several types, and adapted to all conditions and uses.

The subject of panel boards is considered in a special catalogue issued by the Bossert Electrical Construction Co., Utica, N. Y. This is a subject which will be of much interest to the majority of our readers, as it covers a line of switchboards especially adapted to steamship electrical plants. A number of illustrations are given, showing switch boards of various sizes, styles and capacities, and considerable attention is also given to steel boxes, covers for panel board boxes, and kindred subjects.

Users of roofing and siding, and other corrugated and sheet metal products, will be interested in the catalogue just issued by the Youngstown Iron & Steel Roofing Co., Youngstown, Ohio. This catalogue comprises 80 pages, and covers very fully the different branches of this company's business, especially such subjects as the use of sheet metal for shipyard, wharf, and other buildings. Kindred subjects also receive attention, such as that of the proper painting of the metal, methods of applying, weights, sizes, etc.

The Pond Machine Tool Co., 136 Liberty St., New York, has issued for use at the Paris Exposition, a very attractive book devoted to the tool trade. It is bound in stiff board, covered with a light green cloth, and with an illuminated cover in gilt and two shades of green. The book is 5x7 in. in size, and comprises nearly 100 pages, in which are described and handsomely illustrated the works of this company and their many specialties, including engine lathes, planing machines, radial drills, boring and turning mills, and specal machines. The text is given in English, French and German.

Many steam appliances, manufactured by James Bonar & Co., Carnegie Building, Pittsburg, Pa., are fully illustrated and described in a new catalogue just issued. It comprises 74 pages, and is made complete by an index and table of contents. The catalogue is bound in a heavy paper cover, neatly printed, and the text is printed on an excellent quality of paper. The several specialties referred to include the feed water heaters and purifiers, to which many pages are devoted, steam separators, Bonar oil filters, which are shown in section and fully illustrated and described, Bonar gauge cocks, and a line of valves, gauges, revolution counters, traps, injectors, reducing valves, lubricators, etc., which this firm sells.

Sight feed lubricators manufactured by the Detroit Lubricator Co., Detroit, Mich., are fully and thoroughly illustrated and described in the 1900 catalogue, which has just been issued. The catalogue is bound in a neat chocolate colored cover, handsomely embossed, and the text comprises 56 pages, which contain a large number of illustrations and a great deal of reading matter. The many lubricators described include brass and glass oilers, brass and glass oil pumps, oiling devices, boiler oil injectors, low water indicators, globe valves and other specialties. The descriptive part of the reading matter is very complete, and in many instances sectional views are given to add to the completeness of the engravings and text. Copies of this catalogue can undoubtedly be had upon application by referring to MARINE ENGINEERING.

Readers interested in gas engines will find an interesting catalogue on this subject issued by the Noye Manufacturing Co., Buffalo, N. Y., describing the Niagara motor. This is a two-cycle motor, with a number of illustrations showing its application to launches of various sizes. The text describes the features of the engine, such as reversing, method of ignition, etc.

"The Application of Mechanical Draft to Stationary Boilers" is the title of a paper recently read by Mr. Walter B. Snow, and which is published in pamphlet form by the B. F. Sturtevant Co., Jamaica Plain, Mass. The pamphlet comprises 22 pages of text, and illustrations showing the manner in which mechanical draft has been applied in several of the leading mills throughout the country. Copies of the pamphlet can be had upon application.

Pressure regulators, reducing valves, pump governors, and other specialties manufactured by the Foster Engineering Co., Newark, N. J., are briefly described in Circular A, now ready for distribution. Illustrations are given of the several specialties referred to, and there are sectional views, together with tables of sizes and prices, which, with the concise reading matter, make the circular one which will be interesting to our readers.

The Hancock Inspirator Company, 85-89 Liberty street, New York city, has issued its 1900 catalogue, and copies are now ready for distribution. It is of the regulation size, and comprises 40 pages, which contain many illustrations and a great deal of information regarding the several products of this company, which include the Hancock inspirator, the Hancock ejector, the Loftus automatic injector, together with the Hancock shaking grates, Hancock valves, jet apparatus, etc. There is much descriptive matter in the catalogue which will be of value to those of our readers who are at all interested in the subject of steam specialties, and as a closing to the catalogue there is a short history giving the story of the Hancock inspirator and its development.

Marine electrical apparatus which is manufactured by the General Electric Company, 44 Broad street, New York city, is fully described in a neatly printed pamphlet just issued from the press of this company's printing department. The catalogue comprises over sixty pages and contains a large number of half tone engravings of electrical sets and search lights of all kinds.

A neat booklet, pocket size, printed in two colors and with two illustrations on each page, has been issued by the Bullock Electric Mfg. Co., Cincinnati, Ohio, for distribution at the Paris Exposition. It is bound in a cover of gilt, handsomely illuminated in red, white and blue. The text is in both English and French, and gives considerable information regarding the Bullock Works, with its many departments; also illustrations of special applications of electricity, such as direct connected plants, motor-driven tools, large power plants, etc.

BUSINESS NOTES.

Garlock Packing.—Owing to the great extent to which its sales have extended, the Garlock Packing Co. has found it necessary to establish an office and salesroom at 537 Mission St., San Francisco, Cal., in order to be able to fully cover the Pacific Coast.

Galley Fittings.—In addition to a full line of signal lamps of all kinds, Russell & Watson, 145 Main St., Buffalo, N. Y., manufacture and carry in stock a full line of galley fittings of all kinds. They manufacture their own ranges and have supplied most of the steamers on the lakes for many years.

Crumlish Forges.—Early in 1898 the Crumlish Forge Co., Buffalo, N. Y., sold a number of portable forges to the Gas Engine & Power Co. and Charles L. Seabury Co., Con., Morris Heights, New York city. Recently the Crumlish Co. wrote to ask if the forges were satisfactory and received in reply a letter stating: "We take pleasure in stating that they have been so satisfactory that you will have received an order for two more before this reaches you. We cannot say anything more convincing."

Blue Print Paper.—In order to largely increase facilities for handling business, the Mackey Co., Ltd., 25th St. and A. V. Ry., Pittsburg, Pa., has sold its business to the Elliott Electric Blue Print Co. The new company has largely increased the equipment for filling orders by adding new machinery, etc., and will hereafter carry in stock a complete line of Electric blue print paper and supplies. The new company has taken much larger quarters at 723 Liberty Ave., and the business, as heretofore, will be in the hands of Mr. Byron K. Elliott.

Fine Mechanical Tools.—Any users of fine tools will appreciate the convenient arrangement of the catalogue issued by the L. S. Starrett Co., Athol, Mass. Each tool is illustrated with a most excellent wood cut, and is numbered and in other ways keyed, so that it is easy to order anything desired. The catalogue comprises 112 pages, and covers a very complete line of tools, such as bevels, calipers of all kinds, punches, clamps, nippers, gauges, hack saws, levels, micrometers, rules of all kinds, and screw drivers, squares, etc. A copy of the catalogue will be sent to any inquirer.

The Sherwood Injector.—The injectors manufactured by the Sherwood Manufacturing Co., Buffalo, N. Y., have been on the market for some years, and have an established reputation. Among the special features are the following: The injector is operated by one lever, it works at any pressure, from 15 to 200 lbs., will lift 24 ft. under proper conditions, will handle hot water up to 150 deg., is simple, requires no valves and is constructed for wire and sure feed. All the parts are easily accessible. Pictures of this injector, with description of it, together with sectional view showing its construction and the manner of its operation, can be had upon application to the company.

Fan Motors.—Owing to the great popularity of their fan motors, Thomas P. Benton & Son, La Crosse, Wis., have increased their facilities for manufacturing this specialty, and now offer a full line of motors of this type for direct current.

Marine Cement Paint.—The Queens County Varnish Works, Long Island City, New York, are making a specialty of Bailey's Patent Marine Cement Paint. It is anti-corrosive and is especially designed for use on bottoms of iron and steel vessels and also protects from pitting on the inside of hulls. it has been introduced throughout the United States.

Boats and Launches.—During the past year the firm of C. B. Mather & Co., Rowley, Mass., have very largely increased the capacity of their plant by the erection of new buildings and by the addition of machinery. It is the purpose of the company to be prepared to fill orders of any kinds for boats and yachts. The company builds anything, from small rowboats to large launches and yachts, and has special facilities for building ships' boats. An interesting catalogue describing the workmanship of the firm, and giving several types of boats which have become standard, is published.

Shelby Seamless Tube.—The process by which the seamless, cold drawn steel tube manufactured by the Shelby Steel Tube Co., Cleveland, Ohio, is described in a catalogue which has recently been issued, will prove interesting to those who have occasion to use boiler tubing. To all such a copy of the catalogue can be had by applying to the company. Among other things referred to in this catalogue are the specifications which govern the inspection of tubing purchased for the Navy. These specifications show that the tests are very thorough, and it must be evident that the Shelby tubing comes up to these requirements, as the company has furnished an immense amount of tubing, especially for the new torpedo boat destroyers and other vessels which require tubing of the highest quality.

Atlantic Steel Tubing.—Owing to the large increase in its business, the Atlantic Tube Co., whose head offices are at 1209 Park Building, Pittsburgh, Pa., has found it necessary to establish an Eastern office, and this will be in charge of Mr. C. F. Davenport, at 10 Havemeyer Building, New York city. Mr. Davenport has been connected with the boiler trade for many years and is widely known. He will devote his entire attention to the selling of the cold drawn steel tubing manufactured by this company.

Bullock "Teaser" Patents Sustained.—A decree has been entered in the cases of the Bullock Electric Manufacturing Co., vs. Baltimore Evening News and Bullock Electric Manufacturing Co., vs. Geo. Knapp & Co., publishers of the St. Louis *Republic*, sustaining the validity of the "Teaser" patents. The "Teaser" patents cover a system for operating large newspaper presses and other machinery by electricity. The invention is the result of several years of experimenting involving great expense, and this decision gives to the Bullock Company the exclusive right to the manufacture of this apparatus. The "Teaser" system is now installed upon a great many of the largest daily newspaper presses in this country and England.

Philadelphia Pneumatic Tools.—The greatly increased demand for pneumatic tools has been felt by the Philadelphia Pneumatic Tool Co., 21 South 12th St., Philadelphia, Pa. This company is selling a very large number of chipping and calking hammers, not only for use in marine work, but to such large companies as the Pennsylvania Steel Co., The Baldwin Locomotive Works, The Brown & Sharp Co., The Ingersoll-Sargeant Drilling Machine Co., the Bigelow Co. and many others. The Philadelphia Pneumatic Tool Co. reports that its tools have stood very severe competitive tests which have been frequently made. During the past few months the company has more than doubled its shop capacity and it has established branches not only throughout the United States, but throughout Europe and in Japan.

Cross Oil Filters.—The new battleship *Kearsarge* completed her equipment before going into service by ordering Cross oil filters from the Burt Mfg. Co., Akron, Ohio. This company has also just filled an order for its filters for the Navy Yard at San Francisco, Cal.

Handsome Yacht.—A handsome yacht, 108 ft. long, is just having finishing touches put to her at Weller's Shipyard, Trenton, N. J. Her engines were furnished by the Reeves Machine Co., Trenton, N. J., and her boilers by the Almy Water Tube Boiler Co.

Airports and Deck Lenses.—Messrs. J. R. Donnelly Co., 54-60 Classon Ave., Brooklyn, New York, are making a specialty of heavy plate glass for deck lenses and airports, carrying all sizes in stock, in thicknesses from one-half inch to an inch and a half, and can fill orders within a day or two after receipt, made with either nipped or ground edges, as required. This company also furnishes bent glass for pilot houses in either plate or window glass.

Valve Reseating Machines.—The business formerly carried on at Auburn, N. Y., for manufacturing the Dangerfield valve reseating machines has been purchased by Mr. Ward P. Barnum, who has removed the business to Fredonia, N. Y. Mr. Barnum has practically established a new factory throughout, and installed some of the latest and most improved machinery, and is now prepared to fill orders for reseating machines of any size and of any quantity.

Kingsford Boilers and Pumps.—The Kingsford Foundry & Machine Works, Oswego, New York, were unfortunately crippled recently by a fire destroying part of their plant, but not sufficiently as to interfere materially with business. The company is now running its plant with a full force of men, and although very busy is able to fill orders with little or no delay in its boiler departments, as well as in its centrifugal pumping machinery departments. The marine engine department is also very busy. The company has recently shipped a large amount of pumping machinery to Japan and Mexico.

Whitney Gravity Boiler Feeder.—The University Mfg. Co., 25 North Second St., Philadelphia, Pa., is putting on the market the Whitney Gravity hot water steam boiler feeder. Many claims are made for this feeder; among them are the following: It is a positive water feeder with or without steam pressure, scale, rust, sand or gravel have no effect; it will lift water to the full limit of atmospheric pressure, requiring no pumps, injectors, inspirators, or other usual mechanical attachments; it does not overflow and will always furnish dry steam, as in no case will the water rise beyond the desired limit in the boiler. It is claimed to be so simple that a child can turn on and off the water and that there is nothing in it mechanically to get out of order. Its operations are claimed to be as sure as the laws of gravity. Another important claim is that it can easily be regulated to feed one drop of water a minute, or can be changed immediately to its full capacity.

Automatic Engines.—Users of automatic engines for such purposes as operating electric light plants will be interested in the special features claimed for the Shepherd engine, which is manufactured by the American Fire Engine Co., Seneca Falls, N. Y. These engines are especially designed for direct connected work, and other uses where fast running is required such as for fans, pumps, blowers, etc. Many features are claimed, such as adjustment for taking up the wear in the wearing parts. The lubrication is so arranged that there is no need of any throwing of oil about. The frame is solid, and the cylinder and steam chest are cast together. The valve is double ported for both steam and exhaust, and is self-adjusting for steam tightness. It is also collapsible, and acts as a relief valve in case of water in the cylinder. The governor is of the well-known Shepherd type, invented by the designer. A detailed description and many illustrations regarding this engine can be had in the catalogue devoted to it. It is sent to all inquirers.

New Walworth Quarters.—The Walworth Mfg. Co., Boston, Mass., has removed its New York headquarters to rooms 807 and 808, Park Row Building, and will carry in stock a full line of specialties, the same as in the headquarters at Boston. These specialties include many devices well known in the marine field, such as pipe wrenches of different kinds, pipe cutters, pipe end reamers, pipe vises, cock valves of all sizes, pipe joints, etc.

Feather Weight Covering.—A special line of non-conducting plastic covering is offered by the C. W. Trainer Mfg. Co., 89 and 91 Pearl street, Boston, Mass., which has some unusual features, and which is given the name of Feather Weight. It is composed of materials which, in proper proportions and in combinations, give excellent results in non-conducting elements. It is claimed to be practically indestructible, and its lightness, weighing as it does only 60 lbs. to the bag, makes it especially desirable for marine work. A bag contains enough to cover about 40 sq. ft., one inch thick, flat surface.

Duplex Air Compressors.—The Clayton Air Compressor Works, 26 Cortlandt St., New York, have perfected a new type of air compressors and is now ready to fill orders for them. They are built in small and medium sizes and embody all of the latest improvements. This company recently doubled its facilities for work and yet is pressed to its utmost capacity to keep up with orders. Among recent orders the Clayton Company equipped five plants for the Brooklyn Heights Rapid Transit Co. with both compressors and pneumatic hoists and made similar installations in the plants of the Grassolli Chemical Co., De la Vergne Refrigerating Machine Co., General Chemical Co., Union Brewing Co., Gill Machine Works, White's Machine Shops and others. Export trade has increased to such an extent that the Clayton Co. is now sending compressors to all parts of Europe, as well as to Japan, Mexico and several countries in South America.

Varley Duplex Magnet Co.—The Varley Duplex Magnet Co., 137 Seventh St., Jersey City, N. J., which was organized in 1893, has found it necessary to enlarge its scope and a new company of the same name has been organized with a capital stock of three million dollars, of which $500,000 is six per cent. cumulative stock and the balance common stock. The officers of the company remain as before The principal efforts of the company will be in the manufacture of electro magnets. The plant will be enlarged to many times its present capacity. Mr. Richard Varley will continue at the head of the company.

Electric Heaters.—A complete line of electric heaters, such as would be used on board yachts and steam vessels of any kind where electricity is at hand is fully described in a catalogue issued by the Simplex Electric Company, 10 Franklin street, Cambridgeport, Mass. These include a complete line of air heaters, such as would be used for heating cabins and staterooms, which are finished in black, Japan gold, or white enamel as desired. The different sizes and lengths for different conditions. There are also portable stoves of all kinds, from the little heater for curling irons, shaving water and such small uses to stew pans, etc. The catalogue which this company issues describes, in detail, each type of heater.

Queen City Steering Engine.—The steering engine manufactured by the Queen City Engineering Co., Buffalo, N. Y., has many special features claimed for it. It has proved especially efficient for tug boats and other boats of about this size. The steering gear is controlled by a large hand wheel in the pilot house, and is so constructed that by changing a pin from one hole to another, the gear can be used either for hand steering or for power steering. A tell-tale is attached to the gear and indicates the position of the rudder. The operation of this steering gear is noiseless. There is an automatic attachment whereby the steering is stopped when hard over, and this prevents the rudder from striking. A catalogue is issued by the manufacturers which gives several views of this steering gear and considerable information regarding it.

Hyde Windlasses.—The Hyde Windlass Co., Bath, Me., has been furnishing windlasses to some of the best known vessels which have been recently constructed and are being constructed. The steamer *Manna-Hatta*, which has just been delivered by the Harlan & Hollingsworth Company to the Ericsson Line for use between New York and Baltimore, was equipped with Hyde windlasses. Kelley, Spear & Co., Bath, Me., have just launched the fourth of the three-masted schooner barges for the Commercial Towboat Co. of Boston and which is to have a carrying capacity of nearly two thousand tons of coal and which is fitted with Hyde windlasses, hoisting engines, wrecking pumps, etc. The three-masted schooner which Sawyer Bros., Milbridge, Me., are building will also have windlasses, hoists, etc., supplied by the Hyde Company.

ELECTRICITY FOR SHOP DRIVE.—Owing to the great increase in the demand for blocks and other ship chandlery supplies, Wilcox, Crittenden & Co., Middletown, Conn., have made many improvements in their plant including the installation of electric motors.

FOSTER REDUCING VALVES.—The Foster Engineering Co., Newark, N. J., has just made a shipment of a considerable number of Foster reducing valves to the Maryland Steel Co., Sparrow's Point, Md., for use on the torpedo boat destroyers *Truxton, Whipple* and *Worden.* The aggregate weight of the valves is said to have been over three tons.

ELECTRICAL MACHINERY.—The Robbins & Myers Co., Springfield, Ohio, has opened an Eastern agency in the Electrical Exchange Building, 136 Liberty street, New York City, in charge of Mr. W. B. Van de Water. This company has recently enlarged its factory very much and is now in shape to fill orders promptly. Its specialties include a full line of direct current dynamos and motors. Direct connected plants for marine uses will be one of the specialties.

THE BUFFALO FORGE CO.'S ENGINES.—The Buffalo Forge Co., Buffalo, N. Y., finds a rapidly increasing demand for its engines for direct connected electric work. A feature which has been important in pushing the engine has been the fact of its running in oil in a dust and oil tight inclosure, dust providing automatic lubrication. The engine is furnished, however, with open frame if preferred. Its height is a minimum for the floor space occupied. In regulation it is very close. The parts are all accessible, and the entire construction of the engine is as compact as it can be made. This engine is very well illustrated in a picture size catalogue issued by the manufacturers. Several sizes are represented.

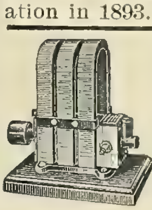
PNEUMATIC RIVETERS.—The Pedrick & Ayer Co., whose selling offices are at 85 Liberty St., New York city, have been giving much attention to perfecting a line of pneumatic riveting machines. The company is now prepared to furnish them of any special design of frame, from portable machines for light work up to the heaviest stationary riveters for ship and boiler work, including hinged riveters for intercostal work on vessels, where it is difficult to get at the rivets to drive them by hand. A decided change in the ratings of the company's machines is noticed in the new catalogue just issued, which gives the total effective pressure exerted on a rivet, with various sizes of standard frames, ranging from 43,000 lb. to 188,000 lb., also the length of the final effective stroke which carries this maximum pressure. Whether the rivets be 1½ in. or 8 in. in length, the construction of the machine takes up the difference instantly, without any adjustment.

ACETYLENE SEARCH LIGHTS.—The Baldwin search light for use on yachts and launches is now being introduced by A. H. Funke, 101 Duane street, New York City. It is very compact, the total height from the deck being only 16 in. and the reflector only 8 in. dia. It gives sufficient power, it is claimed, to "pick up" objects at a distance of 250 ft. The lamp is self contained.

STURTEVANT FANS.—During the past winter the B. F. Sturtevant Co., Jamaica Plains, Mass., has been perfecting its designs and completing its full line of electric propeller ventilating fans for moving air against moderate resistance. These range in ordinary sizes from 18 in. to 60 in. and are provided with direct connected enclosed electric motors. In order to meet the summer demand for these fans the electrical department of the Sturtevant Co. is being worked to its full capacity.

SEMIBRONZE PACKING.—A packing especially designed for use on engines and pumps, called semibronze packing, is manufactured by the Charleston Metallic Packing Co., Charleston, S. C., with a New England office at 32 Oliver St., Boston, Mass. The special claims made for this packing are that it combines the advantages of fibrous packing, with those of metallic packing, that it will not scratch or groove the piston rod, that it requires no special care or attention, is as easily applied as any other packing, is extra lubricating and is practically frictionless. The company has received many orders from the United States Government for the Navy Yard at Norfolk, Va. The last order included a large amount of semibronze packing in sizes from one-quarter of an inch to one and one-half inches. This order was placed immediately after a very complete test was made. Any of our readers who are interested enough to investigate, will have a sample of the packing sent by writing to either the Charleston or Boston offices.

JONES UNDER FEED STOKERS.—Some years ago under feed stokers supplied by the Under Feed Stoker Co. of America, 218 La Salle St., Chicago, Ill., were installed on the tugboat *Perfection* of the Dunham Towing & Wrecking Co. of Chicago. President Dunham, in writing to the Stoker Company, said: "We ran this boat in the season of 1893, before we put in the stokers, with a natural draught with steam jet blower in the breeching. We used the best Pittsburg coal and were unable to get more than about two-thirds steaming capacity for the engine. Since putting in your stokers we have used the boat continuously night and day, burning soft coal screenings, and we are now enabled to get all the steam necessary to drive the engines wide open, and, strange to say, make but little smoke; in fact, I think it is the best smoke preventer that has been found for a tug boat. I am satisfied that we are now running the boat with one-third less expense for fuel; besides we get full power of the engine, which we could not do before. In regard to their practicability in marine work, will say that I think when they are put in right they will give satisfaction on any boat that burns soft coal." Two years later President Dunham wrote a similar complimentary letter to the Stoker Company and followed up his compliments by giving the company an order to equip the tug *Molly Spencer* with stokers. These stokers have been on the market for ten years and in the case of the tug *Perfection* were first put into operation in 1893.



THE BETHLEHEM STEEL CO.—The Bethlehem Steel Co., 100 Broadway, New York city, has opened an office in Denver, Colo., which will be in charge of Mr. C. S. Burt, who was formerly president of the C. S. Burt Co., New Orleans. Mr. Burt's health has obliged him to make a change of climate, and as he represented the Bethlehem Steel Co. in New Orleans, he does not make a new connection with the company.

TWIN SCREW PASSENGER BOAT.—James Beggs & Co., 9 Dey St., New York city, have just completed and delivered for use in Cuban waters a twin screw boat 85 ft. over all and which draws 3 ft. of water when loaded. The hull is of wood, copper finished, and is sheathed with copper. She is fitted with compound engines. This company also furnished all of the parts, including surface condensers, pumps, etc. The speed will be about twelve miles an hour.

MALLEABLE IRON OILERS.—Hammer & Co., Branford, Conn., are offering a line of new and improved patent malleable iron oilers. The chief feature of these oilers is the method of affixing the brass spring bottom. This brass bottom is secured in its place by the use of a seating groove formed into the body of the cup at the point where soldering is usually done. A down turned flange of the brass bottom is forced into this groove, where it has a wide bearing and is then securely soldered. A steel spring is used rendering the bottom proof against setting. This oiler will attract the attention of many engineers, who will undoubtedly want to send for copies of the circular describing it.

A REMARKABLE TRIP.—The yacht *Zeta* weighed anchor from off Audubon Park, New Orleans, on the evening of July 8 last. Her owner made a cruise which consumed the summer and fall months. He made the trip up the Mississippi and through the canals to the Great Lakes, across the State of New York and down the Hudson River. From New York city he started for home and followed the coast line of the Atlantic to the Florida cape and then skirted the shore line of the Mexican Gulf to New Orleans. The *Zeta* is 47 ft. 8 in. on the load water line, 9 ft. beam, and draws about 3 ft. of water aft. Forward there is a strong rail and aft there was a rail, but the sea, off the Florida coast, carried it and the yawl overboard. The cabin house extends across the beam of the craft, leaving only a few inches on each side for a footing. In fact, there is no deck on the sides of the cabin, and only a small deck forward of the pilot house and aft of the engine room. The sides of the cabin are almost entirely made of glass, which gives plenty of air and light to the apartments within. The pilot house serves both as a place for the person at the wheel and sleeping apartments. A polished wood partition separates the pilot house from the main saloon. In this comfortably furnished room there are two seats with folding cushions, and there is accommodation for four persons. A companionway leads along the starboard side of the vessel to the engine room and between the main saloon and the engine room is a stateroom, which is very comfortably furnished. The compact Sintz propelling engine requires but little space and leaves plenty of room for the galley and china lockers. In the run of 6,000 miles, the engine did not fail at any time to do its full duty. The engine was furnished by the Sintz Gas Engine Co., Grand Rapids, Mich.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

PROFESSIONAL CARDS.

A LONG SERVICE.—Mr. Calvin G. Williams, who has been clerk of the Board of Steam Vessel Inspectors at New London, Conn., since Aug. 19, 1875, has retired. There is probably only one other clerk in the service who has served a longer time.

MOSHER BOILERS.—There is now under construction at the Crescent Shipyard, Elizabeth, N. J., about 20,000 I. H. P. of water tube boilers of the Mosher type. These boilers are for various naval vessels and the new fast boat *Arrow*. They are being manufactured for, or under the direction of, the patentee, C. D. Mosher, 1 Broadway, New York.

NAVAL ARCHITECT AND ENGINEER.—An office has been opened at 97 Water St., New York, by Theodore Lucas, who is now open for professional engagements. In a statement of his experience, Mr. Lucas refers to his work "in charge of calculation and estimates at Cramp's shipyard" for a large number of vessels; also as designer of engines for several well known yachts. Mr. Lucas makes a specialty of ship calculations.

DOWN DRAFT FORGES.—The Buffalo Forge Company, Buffalo, N. Y., reports a large demand for down draft forges. There has been a steadily increasing demand for this type of forge, and a number of letters have recently been received from concerns which have them in operation. The Kilson Machine Company, Lowell, Mass., writes: "We have had no trouble with smoke from our blacksmith shop since their adoption." The superintendent of the State Reformatory at Elmira writes: "If I were to install a new plant I should, if possible, secure down draft forges, because we have had such good experience with yours, and I should try to secure an installation of your forges."

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
1616 La Fayette St , Alameda, Cal.

GEO. A. GRUBB, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

ED. R. BLANCHARD, National Treasurer,
583 Fort St. E., Detroit, Mich.

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JOSEPH BROOKS, 6323 Dicks Ave.,	Philadelphia, Pa.
JOHN McG. STERRITT, 129 Broad St.,	New York, N. Y.
JAMES H. TAYLOR, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St., Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN McCLURE, 54 High St., E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 418S. Patterson Park Ave., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St., Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS, Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich.
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S. Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta , Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H. BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

The copper knife switches manufactured by the Bossert Electric Co., Utica, N. Y., are described in price list S, which is now ready for distribution. The list is an 8 page folder, in which the special features of the switches are fully described. The tables on the last page give the capacities of the switches.

A pocket size booklet has been issued by James Bonar & Co., Pittsburg, Pa., giving some fitting remarks to a purchaser of boilers. Although rather more sationary than marine, reference is given to several specialties handled by the firm which will interest marine men. These include the Ashton pop safety valves, Reliance water columns, Bonar gauge cocks, Ashton pressure gauges, etc.

The subject of water-tight doors, as applied to the U. S. cruiser *Atlanta*, has a special bulletin devoted to it, issued by the Sprague Electric Co., 527 West 34th St., New York. The bulletin comprises 18 pages, and contains a number of full-page engravings, showing the manner in which the doors are constructed and operated. The text gives a complete detailed description to accompany the illustrations, and it also tells of tests which were made on the *Atlanta*, and refers to an installation made on the American liner *St. Paul.*

Marine Glasses seem to be such a necessity nowadays that our readers will want to send for a copy of a 24-page booklet issued by the Bausch & Lomb Optical Co., Rochester, N. Y. This booklet describes in much detail the Bausch & Lomb-Zeiss stereo binoculars, which are as far ahead of the ordinary marine glasses in real usefulness as an ocean steamship is of a canalboat. The construction of the glasses is fully explained in the booklet, and the magnifying power is made very apparent by pictures showing tests of one glass against the other. A picture on the last page very graphically shows the great advantage the compact, new style of glasses has over the ordinary binoculars.

Users of tackle blocks will find much of interest in the catalogue on this subject issued by the Union Hardware Company, Torrington, Conn. The catalogue is of pocket size, and comprises 32 pages and cover. All kinds of blocks are illustrated, and accompanying each type are tables giving dimensions and prices, with both common iron bushings and patent roller bushings. Among the different styles of blocks referred to are rope strapped and iron strapped blocks, heavy tackle blocks, wood and steel snatch blocks, hoisting blocks in wood and metal, and wire rope blocks of different kinds. Several pages are devoted to improved, self-adjusting five roller bushings and sheaves. The balance of the catalogue is devoted to such specialties as mast-head trucks and balls, dead-eyes and bull's eyes, calking mallets, belaying pins, tackle and eye block hooks, suction pumps, etc.

Gas engines and hoists, as manufactured by the Weber Gas & Gasoline Engine Co., Kansas City, Mo., have a catalogue of 72 pages and cover devoted to them. The cover is black, with the printing in green and silver. The text pages are of yellow paper, printed in black. The first part of the catalogue is devoted to the stationary engine of all sizes, and much information is given regarding the construction of the engine and its use for various purposes. The text is so complete as to give a good deal of information regarding the care and operating of the engine. The balance of the pages are devoted to special applications of engines, such as portable outfits of many types, and hoisting engines. Several hoists of large size are shown, such as would be used in mines, and a number of smaller ones, especially adapted for use on wharves and docks, as well as on board ship for handling cargoes and other hoisting purposes. Many testimonials show the great variety of uses to which this engine is being put.

The subject of electric overhead transportation has a special circular devoted to it, issued by the Consolidated Telpherage Co., 20 Broad St., New York. This system has been amplified to such an extent that it is now adapted to carrying large and heavy loads, such as would be necessary in loading or unloading fuel, ore, and other such products, either when the vessels are alongside a pier or in an offing. The circular contains a number of illustrations, giving an excellent idea of the system.

The Bullock Electric Manufacturing Company, Cincinnati, Ohio, issued a very handsome souvenir of its factory and products for distribution at the recent convention of master mechanics and master car builders. It is distinctly a book of pictures, as each page has a picture, either of a generator or motor, or of some adaptation of electricity for direct connected work in one form or another, or an illustration of some department of the new factory of this company. The pages are printed only on one side, and are neatly inclosed in a border of different colored ink.

Any young men just entering marine work who seek to raise their papers or in other ways make themselves more efficient by means of study will be interested in two books just issued by the International Correspondence Schools, Box 1111, Scranton, Pa. One booklet, entitled "Support Yourself while Learning to become a Mechanical or Electrical Engineer," is devoted almost exclusively to testimonials from men who have taken some of these courses and to a concise statement of what the requirements are for going on with this work. Outlines of study for several courses are given. The other booklet is made up entirely of testimonials, "Home Endorsements," as stated in the title. On the back cover are concise statements of twenty distinct schools in this institution for educating yourself by means of correspondence.

Every wearer of overclothes will be interested to read the booklet just issued by H. S. Peters, Dover, N. J., which is devoted to the Brotherhood overalls and other overclothes which he manufactures. The book is bound in paper and comprises 16 pages, finely printed on coated paper. The text is very fully illustrated, showing in considerable detail the manner in which these overclothes are made. There are pictures of the factory and of the several departments in which the clothes are cut, made, checked, and shipped. The text is a straightforward, businesslike statement of the good qualities of the Brotherhood clothes. Each special style of garment is fully described, and an excellent engraving shows the manner in which the garment is worn. These include apron overalls, pants overalls, combination coat and vest, sailors' shirts, working shirts and a number of other styles of garments. Copies of the book can be had by writing to the manufacturer.

Steamship Radiators of all kinds, as manufactured by the Fowler & Wolfe Manufacturing Company, The Bourse, Philadelphia, Pa., have a special catalogue devoted to them which has just been issued. Illustrations are given of the many types of radiators, several of which are used on shore as well as on board ship. The many illustrations show the radiator in different forms, from the installation of one section to a considerable number of sections. As the pages are 7 by 9 inches in size, the illustrations are large enough to show the manner in which the sections are ornamented. The special feature of these radiators, emphasized throughout the catalogue, is that they have a maximum surface with a minimum space. The text gives descriptions of the various illustrations and quite an amount of information regarding the subjects of heating and the installing of radiators. A list of steamships is given upon which radiators have been installed, and a full page illustration shows a stateroom fitted with Fowler & Wolfe radiators.

Injector and Ejector Catalogue No. 7 has just been issued by the Sherwood Manufacturing Co., Buffalo, N. Y. It is bound in embossed cover of three colors, and contains 32 pages of illustrations and text. A complete index is the first thing in the catalogue. Then follows an article of two pages concerning injectors. The balance of the catalogue is devoted to the specific subject of injectors and ejectors as manufactured by this company for all purposes. The features of each specialty are fully emphasized, and sectional views are given, with the parts numbered, so that the descriptive matter will be thoroughly understood. Several tables and price lists are also given, together with a few testimonials recently received.

Dean Bros. Steam Pump Works, Indianapolis, Ind., have two new catalogues ready for distribution. Catalogue No. 40 contains lists of parts of pumps, directions for operating pumps, and tables of information. The catalogue comprises 56 pages, and at least half of the space is taken up by illustrations of pumps of several kinds, together with parts of pumps, which are properly numbered, so that ready reference can be made to any separate part. The text applies directly to the several illustrations, making the catalogue one of much value to any user of pumps. There is also quite a little information on hydraulics, boilers, engines, rules for the management and care of stationary boilers, etc. The second catalogue is devoted to duplex steam pumps, and is Special Catalogue No. 38. It is the same size as is the other, and comprises 40 pages and cover. This catalogue, like the other, contains numerous illustrations and tables, together with the necessary descriptive matter. Among the many types of pumps referred to are the admiralty style, ballast and boiler feed pumps, compound pumps, circulating pumps, fire pumps, etc. A copy of either or of both of the catalogues may be had upon application to the manufacturer.

The Latrobe Steel Co., Girard Building, Philadelphia, Pa., has issued a catalogue bound in flexible cloth, devoted to weldless rolled steel flanges, and other specialties. The text will prove interesting reading matter to those of our readers who are interested in this subject.

Users of small steam plants of from two to four horse power for launches or yachts, or on board ship where small power is required, will find an instructive catalogue on this subject in the one issued by the Shortt Duplex High Speed Engine Company, 143 Liberty street, New York Many special features are claimed for this outfit, among others that it affords great power in a small space, that it is simple in construction, easy to operate, that there are no links, no eccentrics, no valve stems, no stuffing boxes, no dead centers. A number of illustrations are given, showing the construction of the engine and of several parts, and the boiler is described and illustrated in a similar way.

Gas Engine Igniters.—Users of gas engines who have trouble with electric sparks will find an interesting circular, issued by the Holtzer-Cabot Electric Co., Brookline, Mass., describing the gas engine igniter which this company manufactures. This igniter has been on the market for some time, so is not a new nor an untried one.

Users of centrifugal pumps will be interested in Bulletin 103, just issued by the Prindle Engineering Co., 120 Liberty St., New York, describing one of the types of pumps manufactured by this company. This company has made a specialty of centrifugal pumps of all kinds, from the smallest one used on board ship to the largest size for dry dock service. A table in this circular gives considerable information regarding the capacity and lift of Prindle pumps of various sizes.

Those of our readers interested in acetylene search lamps, lanterns, and lamps of other kinds, will find an interesting circular devoted to the subject which is issued by the Frank E. Bundy Lamp Co., Elmira, N. Y. Ten lamps of different kind are illustrated, and concise descriptions and price lists are given. Two lamps of particular interest to our readers are the searchlight, which is designed especially for large launches and yachts, and the lantern, which is claimed to be safe for use in the cabin or anywhere. This lantern, like the searchlight, does not smoke, requires no oil, is odorless, and gives a very strong light.

The 1900 catalogue devoted to the Metropolitan injectors is just issued by the manufacturer, the Hayden & Derby Manufacturing Co., 85 Liberty street, New York city. The catalogue comprises 44 pages, 6 by 9 inches in size, and is about equally divided between illustrating and describing the Metropolitan automatic injectors, the Metropolitan "1898" injectors, the Metropolitan double tube injectors, and the H. D. ejectors. A good deal of attention is given in the text to general considerations and to the special subject of applying and caring for ejectors, and there is considerable space devoted to suggestions for piping, repairs, etc. Copies of the catalogue are now ready for investigation.

Lundell generators, direct connected and belted type, have a special catalogue, No. 100, devoted to them, which has just been issued by the Sprague Electric Company, 527 West 34th street, New York city. It is bound in a very neat cover of green paper, printed in red and black. The text comprises 40 or more pages, and to say that the catalogue is of the same quality as all of the Sprague publications tells the story. The size is 7 by 9 inches, and as a number of the illustrations occupy a full page, and are most excellent half tone engravings. the value of them will be at once appreciated. The text is complete, and a number of tables of sizes, dimensions, etc., are given, adding much to the value of the catalogue as a book of reference.

BUSINESS NOTES.

Sails and Covers.—Robert E. Morton, 26 South street, New York, who has been in the sail making business for many years, is now making a specialty of either hand or machine sewed sails, barge covers, canvas covers, tarpaulins, and canvas goods of every description.

A Speedy Yacht.—A handsomely fitted steam yacht has just been built by Hiram Weller's Sons, Trenton, N. J., for Mr. S. B. Wetherill, of Philadelphia. The specifications stipulated that the boat should make a speed of 14 knots. She is a twin-screw boat, and the engines were installed by the Reeves Machine Co., of Trenton. On the recent trial trip the yacht is understood to have made a speed of 15.6 knots before her machinery had been properly "shaken down." The result is a high compliment to the engines of the boat. The boiler was furnished by the Almy Water Tube Boiler Co., of Providence, R. I.

Draughtsmen's Supplies.—The Elliott Electric Blue Print Co., Pittsburg, Pa., met with a great misfortune on June 29 in the loss of its office and factory by fire. The company promptly made arrangements for another factory, and within ten days had sufficient stock on hand to give prompt attention to orders. Since then the company has entirely fitted its new plant, and is now able to furnish all of its products without delay, the new machinery having been installed and put into operation. As this machinery is of the very latest type, the company is in better shape than ever before to fill orders of any size. This company prides itself on the quality of its goods, and claims to be furnishing the most perfect printing paper that can be made The many specialties include blue and black print papers of all kinds, detail and drawing papers, tracing and linen papers, drawing tables and drawing materials—in short, everything in the line of draughtsmen's supplies.

Selden Patent Packing.—The usual experience of those who use the Selden patent packing, manufactured by Randolph Brandt, 38 Cortlandt street, New York, is reflected in that of a chief machinist on one of the fastest torpedo boats in the navy, who writes as follows: "We have been using the Selden patent packing on this boat for two years, against 250 lbs. pressure, and have no trouble whatever. Our engines are four-cylinder triple expansion of 2,200 I. H. P. each. We renew the packing around piston rods and valve stems once in six months, and on these boats, where economy in water is the principal factor in the successful working of the boat, you can imagine our appreciation of a packing that gives no trouble."

Steel Boiler Tubes.—Users of steel boiler tubes will be interested in knowing that the United States government has ordered cold drawn seamless steel tubes for all the boilers to be used in the new vessels for which appropriations have recently been made. The United States naval authorities, who are extremely conservative in making changes, have long favored charcoal-iron lap-welded tubes, and it was only within the last few years that they consented to try steel; and the seamless steel tube has proved so satisfactory that they have finally decided to use nothing else. The British government made exhaustive tests to find out what kind of tubes would best withstand the stresses of boilers used in torpedo boats, and decided in favor of steel. That was several years ago, and nothing but steel tubes have been used in British naval boilers since that day. The basic open hearth steel used in making tubes nowadays has about the same characteristics that the very best grades of charcoal iron had twenty years ago. The Atlantic Tube Co., whose head offices are at 1209 Park Building, Pittsburg, Pa., and New York sales office at 10 Havemeyer Building, in charge of Mr. C. F. Davenport, makes a specialty of cold drawn seamless steel tubes.

CORK TILING.—The Cork Floor & Tile Co., 17 Milk St., Boston, Mass., has installed its products on a number of vessels lately, the most conspicuous ones being the *Pleiades* and the *Hyades*, which were built by the Maryland Steel Co., Sparrow's Point, Maryland, for the Boston Tow Boat Co.

STEAM SEPARATOR.—Engineers and others who are interested in the subject of economy of space in the engine room as well as the economical running of the steam plant, will find in the Potter separator a device which has been introduced on leading steamships. This separator is manufactured by the Potter Separator Co., 39 Cortlandt street, New York. A special claim made for this separator is that it is placed inside of the boiler.

ELECTRIC COOKING.—The Simplex Electric Co., Cambridgeport, Mass., is offering a line of electric kitchen equipments which will be of much interest to those of our readers who are on vessels which have electric current at hand. A circular issued by the company contains a picture of a compact kitchen equipped for electric heat. With such equipment there can be no danger from fire, however much the vessel may roll or pitch, and yet cooking of all kinds can be done. The kitchen outfit depicted is surprisingly cheap, costing only $33.95 for two six-inch stoves, one oven, three plug switches, three double conductor cords, one plated copper three-pint tea kettle, and a plated copper six-inch stew pan.

DEARING WATER TUBE BOILERS.—The Dearing Water Tube Boiler Co., Detroit, Mich., reports an excellent inquiry for its water tube boilers. It has been the aim of this company to supply a boiler which should possess distinctive features and be adapted for use in vessels where it is desired to have a good, all round boiler. One of the special features claimed for this boiler is that it will carry a steady water level either with natural or with forced draft, and will deliver dry steam under all circumstances. These boilers are claimed to be exceptionally good steamers, and to have a maximum of capacity with a minimum of space and weight. Any of our readers interested in the subject of water tube boilers should send for a copy of the catalogue which this company issues.

DURABLE WIRE ROPE.—The special qualities of the patent rope manufactured by the Durable Wire Rope Co., 288 Congress street, Boston, Mass., have attracted a great deal of attention in both the merchant marine and among yachts this season. The rope has the good qualities and the wearing surface of hemp rope and the strength of wire rope. It can be used in place of either manila or wire rope, with the same blocks. This is an important feature, which has helped much to introduce the rope. The durability of this rope is claimed to be many times that of manila, and more than twice that of wire rope. Its flexibility is much greater than any wire rope could have, and is claimed to be even more than manila rope of equal strength. Other important features claimed for the rope are that it is water-proof and rust-proof.

STEEL SHAFTS AND ENGINE FORGINGS.—We are informed by the Bethlehem Steel Co., 100 Broadway, New York, that it has received the order for the entire equipment of steel shafts and engine forgings for the new steamer which the Harlan & Hollingsworth Co., Wilmington, Del., is building for the Mallory Line. The forgings are to be of high grade, open hearth steel, forged under hydraulic pressure, and carefully annealed. The Bethlehem Company is also making shafts and forgings for the 11,000 ton steamer which the Union Iron Works, San Francisco, have under construction for the American Hawaiian S. S. Company. The specifications in this case insisted that this work should be done by the Bethlehem Company. This company has received other similar orders lately for its shafts and forgings for use on locomotives, and on a number of large stationary engines and pumps.

Direct Steam Separator.— The Direct Separator Co., Syracuse, N. Y., has introduced its separator very thoroughly to the stationary trade, and is now giving attention to the marine separator. This separator is designed to take the place of the "dry pipe" in the marine boiler, where there is not room for a separator near the engine. The construction of this device is very simple, and separates the water from the steam very thoroughly. However much the vessel may pitch or roll, it is asserted that the water cannot under any conditions enter the steam current. The separator is readily applied, especially to boilers of the Scotch type. The company issues a most excellent catalogue, a copy of which will be sent to all who are interested in this subject.

Water-Tight Doors.—Those of our readers interested in the subject of water-tight doors will be interested in the system which is being extensively introduced into many of the naval vessels under the patents of the Long Arm System Co., Cleveland, Ohio. The subject of water-tight doors is one to which the rules for marine insurance are requiring an increasing amount of attention. A considerable percentage of the total cost of a large vessel is included in the bulkheads, and these bulkheads in the large compartments are bound to have doors in them. It is these doors that affect the insurance to a great extent. The Long Arm Company claims that for about one per cent of the total cost of the vessel it can make these doors absolutely safe and surely controlled from the bridge, and at the same time leave them individually under the control of any man at any door, either for ordinary use or during an emergency. This additional safeguard greatly reduces the insurance risks, and is an important feature to be considered in connection with every new vessel. The new battle-ship *Maine* will have this system for 30 doors and 10 protective deck hatches. Similar equipments have been ordered for the battle-ship *Missouri*, and equipment for four monitors.

The United States Mineral Wool Co.—The United States Mineral Wool Co., which had offices at No. 2 Cortlandt St., New York, for a number of years, has found it necessary to secure larger quarters, and has taken a suite of rooms in the Central Building, 145 Liberty St. This company is making a specialty of mineral wool for all uses, and is prepared to submit quotations and any other information which may be desired for any work in which mineral wool is used.

The Greenport Basin & Construction Co.—The Greenport Basin & Construction Co., Greenport, Long Island, which has been well known, particularly in yachting circles, for its work, has been incorporated into a stock company. Frederick M. Hoyt is the president; Charles L. Flack, vice-president, and C. Pliny Brigham, secretary and treasurer. The capital stock of the company has been considerably increased, and extensive improvements will be made immediately, with facilities for building new vessels and repairing old ones. The basin and storage facilities are also being very largely increased. With the work in hand completed, the company will be in excellent condition to build larger vessels.

Lubricators.—Our many readers who are interested in the subject of lubricators will find a very interesting catalogue on the subject issued by the Detroit Shipbuilding Co., Detroit, Mich., devoted to the subject. There is a complete line of the Kirby lubricators of several types. These include the double connection lubricator, designed especially for use on marine engines. In these lubricators the sight feed glass is easily cleared by simply opening the valve. This also assists in the operation of the lubricator, as it causes the steam current to pass in the direction of the normal feed. Quite a line of oil pumps and glass oilers is shown. A number of grease cups are also illustrated and described.

The Kitts Steam Trap.—A steam trap which has been on the market for some years, and which is especially designed for use in high pressures, is the Kitts steam trap, manufactured by the Kitts Manufacturing Co., Oswego, N. Y. This trap is of very simple construction, and can be easily opened from the top, and the entire working parts removed for repairing or other purposes. The working parts are suspended from a cross bar by means of compound levers. A long lever carries a weight at one end and a valve at the opposite end, having a very short fulcrum. On the other, or shorter lever, is suspended an open bucket. On the top of the cross bar is a sediment chamber. Although the trap is constructed with weights, the principle is such that the rolling or pitching of a vessel cannot have any serious effect on the action of the trap. The operation of this trap is purely a mechanical one. Several claims are made for this trap, among them that it will work under any pressure, that it has no balls or floats, that it is very small and compact and that it never blows steam, because it is always half full of water.

The Williams Universal Ratchet.—The Waterbury Tool Co., Waterbury, Conn., which manufactures the Williams Universal Ratchet, has found such a demand for a small, compact ratchet that at the suggestion of the Navy Department it is now offering one that is small enough to use under almost any conditions.

Low Water Alarm.—Several serious mishaps have occurred lately because of low water in the boilers, and such accidents could undoubtedly have been avoided by the use of a mechanical device which would have given warning of the state of the water. Among the devices of this kind is the Mathews electric low water alarm, which is manufactured and sold by the Electric Boiler Protection Co., 39 Cortlandt street, New York. This is a new device which has just been put on the market, and full particulars are furnished by the manufacturers to all inquirers.

Moulded Ribbed and Spike Lights.—The J. R. Donnelly Co., 54-60 Classon avenue, Brooklyn, N. Y., manufacturer and dealer in all kinds of glass for ship use, publishes in our advertising columns a list of moulded ribbed and spike lights, on which discounts are quoted on application. This company is also putting on the market a flat polished deck light without any ribs, for use where the space will not admit of using the moulded lights. Correspondence is solicited in reference to this new light, which, by the way, is very much cheaper than the moulded lens, while being just as strong and efficient.

Sails for Yachts and Schooners.—When Wilson & Silsby moved into their new sail loft on Rowe's Wharf, Boston, Mass., about a year ago, they supposed they had allowed space enough for all possible emergencies; but so great has been the firm's business this season that every bit of floor space has been fully utilized, and a great deal of night work has been done since early in the season. This firm has furnished sails for many of the leading yachts which have come out this season, besides new suits for many of the older yachts, and has also done quite an extensive business in furnishing sails for schooners and other vessels.

Asbesto-Metallic Goods.—The asbesto-metallic specialties which are manufactured by the C. W. Trainer Mfg. Co., 89 Pearl street, Boston, Mass., are meeting with an increasing demand all over the world. The company has found it necessary to establish new agencies, and now the packings, gaskets, and other specialties manufactured by this company are for sale by the following agents, in addition to the home office: In Portland, Oregon, by J. M. Arthur & Co.; in Chicago, by the Goodsell Packing Co.; in Lockland, Ohio, by the Phillipp Carey Mfg. Co.; in St Louis, by E. W. Hodgkins; and in Salt Lake City, by the George M. Scott Strevell Hardware Co.

Shop Saws.—The Q. & C. Co., Western Union Building, Chicago, and 107 Liberty street, New York, is offering a line of shop saws which will be interesting to users of such machines. The special claim made for these saws is that they require no attention except to put on the work to be cut off, which is done by men tending other machines.

Oil Filters.—The Imperial Steel Works, owned and operated by the Japanese Government, have placed an order for the complete equipment of the plant with Cross oil filters with the Burt Mfg. Co., Akron, Ohio. As the Burt company was in competition with the best manufacturers of filters in Europe and with other American makes, it regards this as a distinct triumph for the Cross filter. The Imperial Steel Works are probably the most important plant of the kind in Japan.

A Flattering Opinion.—The Kenney Company, 72 Trinity place, New York, sole manufacturer of Flushometers, a system for the manipulation of water closets that supersedes the old-fashioned, noisy, and dirty overhead tank, has received from General E. E. Olcott, of the Hudson River Day Line, the following indorsement: "Three years ago I ordered some of your Flushometers for use on our steamers *Albany* and *New York*. They were so thoroughly satisfactory that later I changed all the old closets for Flushometers. They are certainly the most perfect closet I have seen." Mr. Olcott, moreover, sends an additional order for his private residence and yacht.

The Besly Specialties.—Messrs. Charles H. Besly & Co., 10 and 12 North Canal street, Chicago, Ill., report that their general business has been very good. They are daily making large shipments of their celebrated helmet oil and bonanza cups, and note especial demands from California and vicinity. Their specialties, helmet bronze sheet and wire, Badger and Gardner die stocks, taps of all descriptions, and Gardner grinders, are largely called for by foreign buyers, recent shipments having been made to Japan, England, South America, Germany and Mexico. They are receiving numerous requests for prices, catalogues, etc., for new shop equipment, which they consider a good indication for future orders.

Little Giant Pneumatic Tools.—The business of the Standard Pneumatic Tool Co., Marquette Building, Chicago, Ill., which manufactures the well-known "Little Giant" pneumatic tools and appliances of all kinds, has increased to such an extent that it has been necessary to establish new agencies and increase its force of managers. Mr. A. B. Holmes, who has been connected with the company since its organization, has been promoted to be assistant manager, with headquarters in the Chicago office. The company has opened an office in Pittsburg, 217 Ferguson Building, which is in charge of Mr. William Jennings. The president of the company, Mr. Edward N. Hurley, sailed for Europe last month, for the purpose of establishing works in Germany and France for the European trade. The company has large works in Chippenham, near London, England, but on account of the enormous demand for its products on the Continent during the last year, and the steady increase of this demand, it has seemed advisable to establish additional works in the countries mentioned. Mr. Hurley will also be in attendance at the Paris Exposition, where there are two large exhibits of "Little Giant" pneumatic tools and appliances.

RUBBER GOODS.—The Sayen & Austin Rubber Co., Thirteenth and Commerce Sts., Philadelphia, Pa., offers a large line of rubber goods for all uses, especially the Melville oxidized white sheet gum packing, which is a soft, tenacious compound, unaffected by oils, or acids, and which is especially designed for use on hot steam joints, for boiler gaskets, or for any other pipe connections or other similar uses.

AMERICAN TURRET LATHES.—The American Turret Lathe Co., Wilmington, Del., has recently received an order for a number of heavy semi-automatic turret lathes, to be electrically driven, for the new plant of the New York Shipbuilding Co., Camden, N. J. The electric driving gear will be of the same type as that which was designed for the Shipbuilding Company by Mr. C. M. Conradson, who was the mechanical engineer in installing this new shipbuilding plant, and who is now president of the American Turret Lathe Co.

FALLS HOLLOW STAYBOLTS.—The Falls Hollow Staybolts, manufactured by the Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio, are specified to be used in the boilers which are to be installed in the yacht which the Harlan & Hollingsworth Co. have under contract for Mr. Fletcher of Providence. Large orders for these staybolts have also been given lately by the Morgan Iron Works, Moran Bros. Co., the Bath Iron Works, the Neafie & Levy Co., the Bigelow Co., and other ship and boiler building con erns.

AKRON ELECTRICAL APPARATUS.—The Akron Electrical Manufacturing Co., Akron, Ohio, is offering a direct connected electric plant which can be had for either slow or moderate speed, and for which the highest efficiency is claimed. This company gives a most liberal guarantee regarding its plant. In addition to its electrical apparatus, the company manufactures a commutator truing device, which is proving very popular. Any of our readers who have electric plants to care for should send for copies of the circulars describing this device.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

ENGINEER SEEKS POSITION.

A position is wanted by a marine and mechanical engineer. Best of references. Address MECHANICAL ENGINEER, care MARINE ENGINEERING.

MANAGER OF EXPERIENCE SEEKS POSITION.

A man with many years of experience and with large acquaintance in the field of steam specialties seeks connection with a house in this trade. Address MANAGER, care MARINE ENGINEERING.

EXHAUST WHEELS.—The Protective Ventilator Co., 129 Fulton street, New York, has furnished many of its exhaust wheels lately for ventilating boiler rooms or other places where it is desired to remove smoke, dust, or air. These wheels are made in sizes varying from 12 inches to 60 inches in diameter, and are designed to remove from 750 to 100,000 cubic feet of air per minute. These ventilators can be run by steam engines, electric motors, or as desired. Circulars and other information regarding them and the engines or motors which are furnished when specified can be had from the company.

BOILER FEED CHECK VALVE.—Among the new devices which have just been put on the market is Hough's improved patent boiler feed and relief check valve. This valve is designed to regulate the water which passes to the boilers at each stroke of the feed pump, so that the amount of water shall not vary, even though the ship may be rolling in a rough sea. The arrangement of the feed check and relief under this patent can be applied to any existing valve. The valve is already in use on a number of well-known steam vessels. Full information regarding it can be had from Edward S. Hough, 320 Sansome street, San Francisco, Cal. The London office of the manufacturer is in charge of Mr. E. R. Hough, Billiter Building, London, E. C.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

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This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St , Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
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" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
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" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
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" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS, Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta , Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H. BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

"Useful Information for Practical People," is the title to a pocket size book issued by Foree Bain, Monadnock block, Chicago, Ill. It contains a great deal of valuable information on subjects connected with electricity, mechanics, engineering, and inventions. As Mr. Bain is an expert consulting engineer on subjects pertaining to electricity, mechanics, and patents, most of the matter naturally pertains to subjects which have come under his supervision. There is probably not a reader of MARINE ENGINEERING who would not value this book, and we believe that it is sent free upon application.

The Bickel steam trap, one of the latest specialties on the market, is concisely described in a 6-page folder just issued by Charles Bond, general sales agent, 520 Arch street, Philadelphia, Pa. The folder contains an external, also a sectional, view of the trap. The working of the several parts is very fully explained, and a number of suggestions are given regarding the subject of traps. It is claimed for this trap that it is the most compact one on the market, and that it will always work, regardless of the pressure at either the outlet or the inlet, unless it is expected to discharge against a pressure greater than the head pressure—a hardly probable condition.

A very handsome and complete catalogue is now ready for distribution by the Morse Twist Drill & Machine Company, New Bedford, Mass., describing this company's many products. The catalogue is 6 by 9 in. in size, and comprises 120 very handsomely printed and illustrated pages. Among the many specialties which are particularly emphasized in the book are increase and constant angle twist drills, chucks, reamers, milling cutters, taps and dies, and machinists' tools. Much value is added to the catalogue by a very complete index covering nearly seven pages. Any of our readers who have use in any way for any of the tools mentioned will find this catalogue a valuable one for reference.

Two bulletins have just been issued by the Sprague Electric Company, 527 West Thirty-fourth street, New York. Bulletin No. 200 is devoted to Lundell motor equipments for printing establishments and book binderies. Although not specifically marine, the subject is one which will interest every user of electrically operated machinery, as the bulletin comprises 32 large pages, which are very fully illustrated, showing the manner in which machinery of all kinds in printing offices is run by electricity. The text is very complete, and altogether the bulletin is one of more than ordinary interest. The other bulletin is No. 401, and is devoted to the subject of Greenfield flexible steel armored conductors. This comprises four pages, which contain a number of illustrations of this conductor and flexible cord, together with applications of it. This bulletin will be of special interest to electricians connected with marine work of any kind.

Perfection berths, as manufactured by Lein, Irvine & Company, 328 East Twenty-third street, New York, are shown in much detail in a catalogue just issued. This firm has made a specialty of fitting vessels of all kinds, from large ocean liners and army transports to coastwise vessels, freight steamers, and other vessels, with comfortable and compact berths of all classes. Each type of berth fitting is illustrated and concisely described in this catalogue, and different views are given emphasizing the special features for each berth. The illustrations include permanent berths and portable ones, berths which can be folded and berths which are stationary. There is also a very compact arrangement of berths, both stationary and folding, which has been very generally made use of on the government transports. The subject is so fully covered by this catalogue that any of our readers interested in such specialties should send for a copy.

The patented ventilators manufactured by the National Pancoast Ventilator Company, Drexel building, Philadelphia, Pa., are very well illustrated and described in a 32-page catalogue, with cover, now ready for distribution. These ventilators have been on the market for many years, and are used on some of the best known buildings throughout the country. There are also skylight ventilators, which will be of particular interest for use on steam vessels. The principle of the ventilators is very well explained in several of the illustrations.

A special catalogue is sent free to all inquirers by the Chicago Pneumatic Tool Company, Monadnock Block, Chicago, which has just been issued. Although intended principally for two recent conventions of railroad men, it is of interest to any user of pneumatic tools, as most of the 32 pages are devoted to different kinds of these tools. The illustrations are nearly full-page size, and are of most excellent quality. They illustrate riveting hammers, caulking hammers, drills of all kinds, flue cutters, stay bolt cutters, jacks, pneumatic painting machines, riveters, cranes, etc. A number of illustrations also show the manner in which the tools are used. Copies of the catalogue can be had upon application.

Some facts about asbestos covering are concisely stated in a 4-page, three colored folder which has just been issued by the H. W. Johns Manufacturing Company. It refers especially to the asbestos fire felt sectional covering which has been one of this company's leading specialties for a number of years. As stated in the folder, this covering is made in cylindrical sections three feet long, to fit pipe of standard measurement. It is also made in sheets and in roll form. Emphasis is laid upon the fact that this is not a hard molded, brittle covering, nor is it affected by moisture or heat nor destroyed by vibration or rough usage. Copies of the folder and samples of the covering can be had upon application to the H. W. Johns Manufacturing Company, 100 William street, New York.

The blowers manufactured by the New York Blower Company, 39 Cortlandt street, New York, have a number of circulars devoted to them which have just been issued. The circulars are sent out in a large envelope, illuminated in a very patriotic manner with pictures of the American flag. The folders themselves each contain an illustration of a different type of blower, and one of them has a very interesting set of pictures noting the changes which have been made in the American flag, beginning with 1775 and ending with the adding of the forty-fifth star in 1896. One of the folders gives a startling picture of what are claimed to be two of the largest mechanical draft fans ever built. Any of our readers who are interested in the subject can secure copies of these pictures, suitable for framing, by applying to the manufacturers.

Users of launches will be much interested in the catalogue entitled "Electric Launches," issued by the Electric Launch Company, 100 Broadway, New York. It is very handsomely published, on fine quality of paper, and comprises 88 pages. A table of contents adds much to the completeness of the catalogue. The first 20 pages are devoted to pictures and descriptions of launches of different sizes and types; then follow a number of pages devoted to the electrical equipment of the boats, including the steering gear, motor, storage batteries, etc. Several pages are devoted to price lists, and scattered all through the book are pictures of launches of all kinds which have been made. There is also much information regarding the subject of speed, capacity, etc. The subject of charging the batteries is an important point, which is fully discussed in several pages in the back part of the catalogue, and the yacht and lighting electric plants which this company furnishes are also shown.

The Faultless metallic packing, manufactured by the Hoyt Metal Company, St. Louis, Mo., is illustrated and described in a 16-page pocket size booklet now ready for distribution. The booklet is bound in a dark green paper cover printed in gold. The text pages contain a number of illustrations of the packing, a table of prices, and some half dozen testimonials from leading concerns which have used the packing.

The Keystone motors, used for both launches and automobiles, have a special catalogue devoted to them, issued by the Keystone Motor Company, Drexel building, Philadelphia, Pa. It is an exceptionally neat catalogue, bound in a rich red cover, printed in black. The text comprises 16 pages, printed in two colors, giving numerous illustrations of various types of "autocycles," as the vehicles are called, and also giving considerable information regarding the engines. Undoubtedly any of our readers interested in the subject of gasoline launch engines or automobiles can have a copy upon application.

A course in gas engineering is offered by the A. Van der Naillen School of Engineering, 933 Market street, San Francisco, Cal. Any of our readers interested in the subject should send for a prospectus of the course, which is now ready for distribution.

Some of the steam specialties manufactured by the Sherwood Manufacturing Company, Buffalo, N. Y., are illustrated in a 4-page folder now ready for distribution. Each specialty is illustrated and concisely described. They include injectors, lubricators of eight different kinds and types, boiler flue cleaners, etc.

Fittings for steam vehicles, which are manufacfactured by the Ashton Valve Company, 271 Franklin street, Boston, Mass., have an 8-page booklet with cover devoted to them. Among the fittings illustrated and described are Ashton pop safety valves, Ashton cylinder relief valves, Ashton pressure gauges, water gauges, etc.

Waiting for a match is the concise statement on a card issued by Patterson, Gottfried & Hunter, Ltd., 146 Center street, New York. As the card has some features connected with it making it very useful to hang up in an engine room or office, the suspense of waiting for the match should be broken by all of our readers by sending for the card.

Ransome's concrete mixers have a 20-page catalogue devoted to them. The mixers are illustrated and fully described, and a number of testimonials are given by concerns which have used the mixers to advantage. Copies of the catalogue and more detailed information can be had from the Ransome & Smith Company, 17 Ninth street, Brooklyn.

The Russ motor is one of the recent gas engines seeking favors in the yachting field. A catalogue comprising 12 pages descriptive of the motor and giving an illustration of it, is now ready for distribution. The special features claimed for the motor are emphasized in this catalogue, copies of which can be had from the Russ Motor Company, 65 Delavan street, Brooklyn, N. Y.

Monitor Packing.—A packing designed for high pressure and high speeds, called the Monitor packing, is one of the specialties sold by Joseph Allen, No. 1 South Front street, Philadelphia. This packing can be ordered in sets or by the pound to rod and box measurements. Two high pressure rings come with each set, unless otherwise ordered. Information and samples can be had upon inquiry.

Some words of wisdom about paint for the man that pays the bill and the man that owns the roof are seeking opportunity to disseminate themselves. They are concisely printed in an 8-page pocket size booklet with cover, and they give considerable information regarding the different kinds of graphite paint manufactured by the Joseph Dixon Crucible Company, Jersey City, N. J. Any of our readers who are interested in the subject of paint, whether seeking wisdom or not, will find this booklet very readable.

BUSINESS NOTES.

Big Dredging Contract.—The Atlantic, Gulf & Pacific Company, Park Row Building, New York, has been awarded the contract for a large amount of dredging in the Potomac River, opposite the city of Washington.

Powerful Binoculars.—A traveler who sailed for Liverpool in July, and who took with him a pair of 12-power binoculars, manufactured by the Bausch & Lomb Optical Company, Rochester, N. Y., writes: "The binoculars are magnificent, but are so powerful that it requires practice to use them. Just before reaching port a British cruiser passed us, and I could read the signals on her with the glasses, while the officer on the bridge was unable to even see the signals with his marine glasses, and reported that the vessel did not signal us." Users of marine glasses will appreciate what a distinction this demonstrates there is between modern binoculars and the old fashioned marine glasses.

Pneumatic Hammers.—Thomas H. Dallett & Co., York St. and Sedgley Ave., Philadelphia, Pa., are putting on the market a line of pneumatic chipping and riveting tools. These tools are designed to do the heaviest duty without jar or shock to the operator. The hammer is of the "valve long stroke" type, the valve being substantial and not liable to break. All the working parts of these tools are made of steel which has been carefully hardened, and which is accurately ground to gauge. The admission valve in the handle is so designed that the operator has instant and sensitive control of the strength of the blow to be struck, so even with the largest sizes of tools, an instant change can be made from the full power of the hammer to the lightest cutting. Further details, with pictures of the tools, are sent to all who are interested in them.

Universal Grinding Machines.—Manufacturers of engines, pumps, and other such apparatus who have not studied carefully into the subject of grinding for finishing and other special work, will find it a subject of deep interest, and will appreciate the value of the catalogue, giving much information, issued by the Landis Tool Company, Waynesboro, Pa. This company manufactures a full line of grinding machines, designed especially for such work as would be called for in engineering establishments. The catalogue illustrates and describes these machines, and is especially valuable on account of the thoroughness with which the subject is covered.

Metal Working Tools.—Mr. W. E. Shipley, whose offices are in the machinery department of The Bourse, Philadelphia, Pa., now has the agency of some of the leading concerns in the country which are supplying machine tools of all kinds to ship yards and engineering establishments. Among these concerns, with their specialties, are the following: The Lodge & Shipley Machine Tool Company, lathes; the Cincinnati Milling Machine Company, milling machines; the Bickford Drill & Tool Company, radial drills; the Cincinnati Planer Company; the Cincinnati Machine Tool Company, upright drills; the Reeves Pulley Company, variable speed countershaft; the Ferracute Machine Company, punches and dies; J. E. Snyder, upright drills; the Whitcomb Manufacturing Company, planers; the National Machinery Company, bolt cutters, etc.; Walker magnetic chucks; the Windsor Machine Company, screw machines and monitor lathes; crank, geared, link, and friction shapers; Becker-Brainard Milling Machine Company, vertical milling machines; James Clark, Jr., & Company, "Willey" electrically driven tools; the Union Tire Company, tapping attachments and drill presses; the W. P. Davis Machine Company, lathes, keyseaters, and cutting-off machines; L. S. Heald & Son, American twist drill grinder; chucks and attachments.

Results from Advertising.—Mr. Ray D. Lillibridge, 20 Broad street, New York, who makes a specialty of systematizing business, has recently issued a circular which gives many excellent points regarding the subject of advertising, especially showing the lack of attention from which this important part of every business sometimes suffers. The subject is illustrated by referring to letters sent to eighty representative concerns, inquiring for prospective business. Only three replies were received which showed a reasonably carefully systematized effort to follow up their advertising and get this new business. The circular illustrates the importance of giving careful attention to inquiries, and will be good reading to those who are seeking more systematic methods of handling their business.

The Paragon Boiler.—The boiler recently put on the market and which was designed by Captain M. De Puy, 19 South street, New York, has come into such general demand that an order has just been received for two of these boilers of 100 horse power each, from Victoria, Australia. These boilers have been proving themselves desirable for use on river boats, and among the most recent inquiries for this purpose is B. R. Haskell, Memphis, Tenn. The inventor emphasizes several claims in connection with the Paragon boiler, especially the one that it developes a horse power to every six square feet of heat surface.

Increased Rate of Combustion.—Independently of the greater economy and higher rates of combustion, mechanical draft stands as the only means by which the increased rate can be economically obtained. Coincidentally the boiler capacity must of necessity be greater, provided the grate area is maintained. As observed by A. J. Durston, "as long as draft was dependent upon a funnel for its production, a much greater combustion than 25 pounds of coal per square foot of grate was rarely achieved; with artificial draft, on the other hand, the rate of combustion may be accelerated to any amount, and as a boiler's capability of transmitting heat without injury to itself is simply a matter of degree, experience has been necessary to determine the rates of combustion that can with safety be employed with different types of boilers." When it is considered that in boilers of the marine type the combustion rate resulting from the employment of mechanical draft is now carried as high as 40 to 50 pounds, that in torpedo boat and similar service a rate of 70 to 80 pounds is frequent, and in locomotive practice as high as 120 pounds is not at all unusual, the possibilities of increased rates of combustion with mechanical draft are evident.—Extract from Treatise on Mechanical Draft. By B. F. Sturtevant Co., Jamaica Plain, Mass.

Cross Oil Filters.—The Burt Manufacturing Company, Akron, Ohio, made some important shipments of Cross oil filters, particularly on export orders, during the past month. These orders came fom Denmark, Sweden, Spain, France, England, and Mexico. The Burt Company reports a steadily increasing demand for these filters in all directions, foreign and domestic.

Big Dry Dock.—The Tietjen & Lang Company, Hoboken, N. J., which has taken a lease of a thousand feet of shore front in Weehawken Cove, just north of Hoboken, has been for some time at work on the construction of an immense floating dry dock. With 40 ft. of water at low tide, and the new dock in working order, this company will be in shape to handle repair work to the best advantage.

Marine Boilers for Launches.—One of the best and most popular coal burning boilers for a small launch made is the submerged tube vertical marine, provided it is designed, built, and fitted out for the service as it should be, and yet there is probably no type of launch boiler whose possible value is less understood. There are two reasons for this. First, In the best design and construction they are expensive to build, and yet they present great opportunities for cheapening. Even the best of them, built and fitted out in the most thorough manner for marine duty and highest pressures, present about the same appearance to the ordinary observer as "a cheap vertical boiler," though there may be a difference of fifty per cent in cost between the two. Not attempting to enumerate all the differences, we may mention in addition to the higher grade material and workmanship put into the best of these boilers: the extra quality of tubes; the form of the "cone" top, allowing the right amount of steam storage space to prevent foaming and syphoning the water over into the engine; the number, size, and character of the stay bolts; suitable provision for cleaning interior of boiler; the ample diameter of fire-box as compared to the height of the boiler; form of the smoke hood and ash pan, as also the "trimmings." Second. Submerged tube marine boilers receive occasional unfair usage, for their splendid draft and heating surface tempts one "to see how quickly steam can be raised from cold water," and although these boilers when built and fitted out as they should be will stand considerable abuse, an unfair forcing of the fire before the water has had an opportunity of warming up the boiler will occasion leaky tubes or joints. Very few of the marine shops care to figure on building these small boilers, unless in connection with other machinery, where the engines and auxiliaries form a part of the bid, for they cannot afford to cheapen the work and thereby risk their reputation, neither do they wish to appear as overcharging, when as a matter of fact the margin of profit on all of this higher grade work is less than it should be. While it is true that the saving in the first cost to the purchaser can only be effected once, that too often has a greater influence on his judgment than the more serious considerations of safety and durability, though it is a well demonstrated fact that these boilers, built in the thorough and careful manner herein referred to, will under good treatment give five times the service of the common cheap type. Some interesting literature on the subject of boilers of this type is issued for free circulation by the Marine Iron Works, Station A, Chicago, Ill.

Large Dredging Contract.—The contractor who some time ago took the contract to do dredging in the harbor of Portland, Me., having failed to fulfill his agreement, the government has canceled the contract, and made arrangements with Morris & Cumings, 22 State street, New York, to finish the job.

Portable Key-Seating Machine.—A new device which will interest many of our readers is a portable key-seating machine which is being put on the market by the John Leisenring Mfg. Co., Belmont and Elm avenues, Philadelphia, Pa. These machines are made in all sizes, to be operated by hand, by electric motor, or by a flexible shaft or pulley. It is claimed for the machine that it will cut a key-way accurately and in perfect alignment at the rate of one inch per minute. More detailed information can be had from the manufacturers.

Paine Engines.—James H. Paine & Sons, Clayton and Park streets, Boston, Mass., are meeting with much success with a line of compound engines which are called Class A. These engines have cylinders 10 and 20 in. with a 14 in. stroke. The bedplate is 43 by 38 in. The height of the engine above the center of the shaft is 76 in. The crank shaft is forged of mild steel, with the cranks cut out of the solid. The connecting rods, eccentric rods, and front columns are forged of mild steel. The links are of the double bar type. The valves are piston valves. The cranks are counterbalanced, and a bar wheel is fitted. Automatic water relief valves are fitted to both cylinders, and there is a complete oil service. The engine is nicely finished, and the cylinders are neatly lagged. All bearings and surfaces are of large area, and all ports and passages are of ample size. The materials used are of the best quality, and the workmanship is of the highest grade. Thrust bearing is built on the engine shaft when desired. When desired, these engines are built triple expansion, in sizes up to 500 I.H.P.

Flushometer Patents.—Owing to the success which has attended the flushometer system in connection with marine and other water closets, the Kenney Company, 72 and 74 Trinity place, New York, which owns the patents, announces that it will begin suit immediately against a number of imitations of this system.

Potter Separators.—The Potter Separator Company, 39 Cortlandt street, New York, has received an order from Messrs. Harland & Wolff, Ltd., Belfast, Ieland, for a complete outfit of Potter steam separators for the American liner *Philadelphia*, formerly the *Paris*. The general agency for this separator for the United States has been taken by Messrs. James Beggs & Company, 9 Dey street, New York.

Fine Mechanical Tools.—Early in August the L. S. Starrett Company, Athol, Mass., shut down for the usual two weeks' vacation in order to make necessary alterations and repairs. This shut-down was begrudgingly given, because business was so brisk that the company was already finding it difficult to keep up with its orders. Such improvements were made in the facilities of the shops, however, that it is believed that the loss of time will soon be made up for, especially as the men have been rushed with work for many months without a break. During the shutdown the company added quite a number of screw machines and other machinery.

Asbestos Steam Packing.—The H. W. Johns Manufacturing Company, 100 William street, New York, reports a steadily increasing demand for the H. W. Johns asbestos steam packing. This packing is made flat, round, or square, and is made with especial reference for use in high pressures. The claim is made that less oil is required with this packing than with most other packings, as the material itself is to a large extent self-lubricating. Another important claim is that oils made from petroleum work as well with this packing as lard or sperm oil. Because of its being made of asbestos, this packing is not affected by acids, and will stand long exposure to dampness or any degree of heat. Samples of this packing and descriptive price list are sent free to all inquirers.

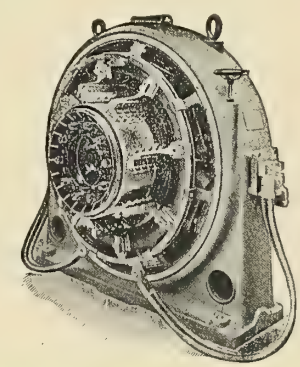
Draftsmen's Supplies.—Draftsmen who have occasion to buy supplies of any kind will find a valuable book of reference known as Sample Book M, issued by the Elliott Electric Blue Print Company, 723 Liberty avenue, Pittsburg, Pa. This book gives much information regarding blue print paper, detail paper, tracing linens, drawing inks, and other draftsmen's supplies of which this company makes a specialty. A new specialty which this company is offering and which is very popular in drafting rooms, is "Write White." It is used especially for making changes or alterations on blue prints. This fluid does not spread and will not corrode the pen, and has many other special features which are told about by the manufacturers.

Eureka Packing.—James L. Robertson & Sons, 218 Fulton street, New York, report that marine engineers are asking more and more for Eureka packing. This packing is easily placed in position with the fingers, and is sold ready for use. The "red diamond" always identifies this packing.

The Besly Specialties.—Charles H. Besly & Company, 10 North Canal street, Chicago, Ill., report that in spite of its being midsummer, and a Presidential campaign year, business is as brisk as they could ask. The lubrication of machinery is calling for a large amount of Helmet oil throughout all parts of the United States. This firm has also received orders for two complete shop equipments, to go to India, including lathes, chucks, drills, screw plates, etc. Gardner grinders are also in demand. In general machinist supplies, this firm reports as great a demand as at any time during many months past. An excellent idea of the full line of specialties carried by this firm can be had from the catalogue which is sent free to any one writing for a copy.

Cushions, Napery, Etc.—Owing to the steady increase in his business, Mr. M. W. Fogg moved some time ago to quarters over three times the size of those formerly occupied, and is now located at No. 20 Fulton street, corner of Front, New York. In spite of the greatly increased capacity of his establishment, Mr. Fogg has found that the new place is none too large, as the business in the new location has called into use all of his facilities. He makes a specialty of everything required in the furnishing of yachts and vessels, such as cushions, mattresses, draperies, table linen, bedding, etc. The business includes the entire furnishing of single yachts or of entire fleets, not only in furnishing new, but in maintaining the supply up to any required standard.

Fog Signals.—The rules and regulations of the U. S. Steam Vessel Inspection Service are very strict regarding the use of fog signals, not only on large steam vessels, but on sailing vessels, yachts, launches, etc. On vessels where there is no steam for blowing a whistle the law requires some other device. One of the most complete lines of fog signals operated by air is that manufactured by the Gleason Peters Air Pump Company, Mercer and Houston streets, New York. The cuts in the advertisement show two types of outfits. The smallest one is a portable pump, held to the deck by one foot and operated by hand, like an ordinary bicycle pump. Attached to the side of the air chamber is the whistle. Each stroke of the piston in this pump gives a long blast. The price of this signal is such as to bring it within the reach of anybody. A larger outfit, employing the storage of air in a cylinder, is also illustrated. This is especially designed for use on schooners and yachts of all kinds. Air is stored in a tank placed in any convenient position, the compressing of the air being automatically done by a small pump operated either by hand or mechanically. Attached to this tank is a whistle and also a gauge showing the air pressure. These outfits are made for schooners of large size if desired, and the whistle can be of such size as to give a signal sufficiently loud for any conditions. It may not be generally known that the law on the Atlantic and Pacific coasts requires that a sailing vessel under way shall sound, at intervals of not more than one minute, one blast of a foghorn when on the starboard tack; two blasts in succession when on the port tack; and three blasts in succession when with the wind abaft the beam. Launches and motor boats and other craft, even to rowboats, are required to sound a blast of a foghorn or equivalent signal at intervals of not more than one minute. Similar rules apply on the Great Lakes and also on other waterways of the country. With such stringent laws requiring the use of fog signals, many of our readers will be interested in the complete line offered by the Gleason Peters Company.



A Good Record.—Kelley, Spear & Company, Bath, Me., who began business in 1888, recently launched their 98th vessel, and within a few weeks will have two more going overboard, making 100 vessels within this short period. These include 48 barges, 1 bark, 2 steam barks, 4 two masted schooners, 20 three-masted schooners, 10 four-masted schooners, 2 barkentines, 6 scows, 1 stern wheel steamer, 1 raft boat, 2 tow boats, and 1 dredge.

Bordo Plug Valve.—John Meneely, 309 Arch street, Philadelphia, recently offered to the trade the Bordo plug valve, and he reports a very extensive demand for it. The special features claimed for this valve are that it is balanced, that it opens with a quarter turn, that it never raises from its seat, is always perfectly tight, will not stick, has full pipe area in the box, and is easily adjusted to take up wear. The valves are made in sizes from 1-4 in. to 4 in.

Mechanical Thermometers.—Users of mechanical thermometers for any purpose will be interested in a line of small circulars issued by the Helios-Upton Company, Peabody, Mass., which illustrate and describe the full line of such goods of which this company makes a specialty. Many of the vessels in the United States Navy and numerous coastwise and ocean going vessels have been entirely equipped with thermometers, barometers, and other specialties of this company.

Magnolia Metal.—The Q. & C. Company, Western Union Building, Chicago, and 106 Liberty street, New York, announces an excellent demand for the well known Magnolia metal which this company now sells. This metal has been well known in engineering fields for many years, and has been extensively used by steamship lines, navies, and for other uses calling for such metal in all parts of the world. The results are reported as having been highly satisfactory on high speed engines and for bearings where other metals have not proved satisfactory.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

EXPERIENCED BOILER AND ENGINE MAN SEEKS POSITION.

A mechanical engineer with a very large experience in marine and stationary engine and boiler work is open for engagement as manager or superintendent and chief draftsman of works. Highest testimonials. Address ENGINEER, care MARINE ENGINEERING, N. Y.

PROFESSIONAL CARDS.

Asbestos Goods.—The C. W. Trainer Manufacturing Company, Boston, Mass., has recently covered the boilers on the ocean-going towboats *Tormentor* and *Buccaneer*, owned by Haley & Appleton, of Boston, with featherweight plastic covering. This covering has already been extensively used on other vessels, one of the recent orders being for the boilers on the ferryboat which has just been built for the city of Boston. In addition to this covering for boilers and steam pipes, the Trainer Company makes a very full line of asbestos materials, including packing, fireproof cloth, rope, etc.

Weatherproof White Enamel.—Harrison Brothers & Company, Inc., Philadelphia, Pa., are now offering a new white enamel, designed especially for exterior work, and which is sold under the name of "Weatherproof" white enamel. It is especially intended for outside work, such as on deck houses, hulls, and other parts of ships and yachts, and is believed to be equally as good for iron or other metal as for wood surfaces. The claim is made for this enamel that it will not check, crack, or flake under the most severe exposure to the elements, and that salt atmosphere has no effect whatever upon it. Another important claim is that soot and smoke do not adhere to it, and can be readily removed by washing.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
1616 La Fayette St , Alameda, Cal.

GEO. A. GRUBB, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

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JAMES H. TAYLOR, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St , Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN McCLURE, 54 High St , E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 418S. Patterson Park Ave., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St.. Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½. Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich.
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M. MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W. Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S. Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta , Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H.. HALL, Box 512, New Berne, N. C.
" 104, J. H BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

Knife switches of the Colonial type which are sold by the Crouse-Hinds Electric Company, Syracuse, N. Y., are illustrated and briefly referred to in a 4-page folder which is now being distributed.

Users of gas engines will be interested in a pocket size catalogue issued by the Delaware Machine Works, Wilmington, Del., descriptive of the Hercules marine vapor engines. The type of this engine is shown by the illustrations, and tables giving information regarding sizes, etc. A strong guarantee is also published.

Packings and valves are told about in a neat pocket size booklet issued by the Mechanical Rubber Company, Cleveland, Ohio. Several grades of sheet packing are described with considerable detail, and much information is given regarding them. There is also quite a little attention given to piston packings of various kinds and for all pressures. There is also a combination packing illustrated and described. The balance of the catalogue is devoted to gaskets and valves. A table of sizes and a price list add much to the completeness of the catalogue.

Single style steam pumps, manufactured by Dean Bros. Steam Pump Works, Indianapolis, Ind., are described in special catalogue No. 42, just issued. This catalogue comprises 72 pages, and is devoted exclusviely to this style of pump, so that those of our readers in sending for a copy should specify the number. The catalogue is about 6 in. square, and there is an average of nearly a cut to a page, giving an idea of what a thorough catalogue it is, in addition to the many illustrations, there is sufficient text to concisely describe the several pumps, and there are many tables of capacities, sizes, etc. The catalogue is one which will be of much value for reference to any one who is interested in the subject of steam pumps.

The subject of electric heating is treated in a most interesting and thorough manner in a very complete catalogue just issued by the Simplex Electrical Company, Cambridgeport, Mass. This is the sixth catalogue issued by this company descriptive of miscellaneous electric heating apparatus. Four years ago a catalogue of 20 pages sufficed to describe the heaters then manufactured. The present one comprises nearly 60 pages and covers ten times as many items. There are many things illustrated and described in this catalogue which will interest our readers, especially electric griddles, broilers, toasters, hot water urns, flatirons, and cooking and heating utensils, which have already been extensively introduced on board many steam vessels and yachts. The index adds much to the completeness of the catalogue. The illustrations are very numerous and of excellent quality.

The Twentieth Century tool catalogue is now ready for distribution by Montgomery & Company, 105 Fulton street, New York. It is a concise, compact, and comprehensive as a catalogue could well be. It is about 4x6 in. in size and comprizes 532 pages. Some idea as to the comprehensiveness of the catalogue can be gained by the fact that the index covers nine pages. Almost every article that the manufacturer, mechanic, engineer, or machinist could look for is illustrated, and a complete line of sizes, with prices and other information, is given. Every user of tools should send for a copy for the value it would be as a work of reference and in making purchases. Draughtsmen would also find this catalogue invaluable for the same purpose. Scarcely a subject or article is referred to which does not have illustrations accompanying it. We have no doubt that copies will be sent upon application by mentioning MARINE ENGINEERING. A supplementary catalogue is also issued by Montgomery & Company, comprising 40 pages, and devoted exclusively to the subject of bolts and screws. The tables and illustrations make this catalogue of much value.

A nautical preparatory school has been established in Boston, and circulars regarding it are now being distributed by the Naut cal Preparatory School, P. O. Box 2416, Boston, Mass. The school is under the charge of Lieutenant C. H. Harlow, U. S. Navy.

The use of graphite in foundry work is discussed in a booklet which has just been issued by the Joseph Dixon Crucible Company, Jersey City, N. J., under the title of Facings. Any of our readers interested in the subject can secure a copy upon application.

The educational series known as the Hawkins set is described in a catalogue issued by the publishers, Theodore Audel & Company, 63 Fifth avenue, New York city. The catalogue describes with much completeness each one of the six volumes. The volumes comprise a catechism of electricity, aid to engineers' examinations, instructions for the boiler-room, calculations for engineers, catechism of the steam engine, and an indicator catechism. The catalogue states that arrangements are made by which these books can be purchased on the payment of only $1.00 per month.

A beautifully executed catalogue has just been issued by the Niles Tool Works Company, of Hamilton, Ohio. It is bound in morocco, with flexible cover, and comprises 169 pages. The paper is a fine quality of coated stock, and the printing is in two colors, red and black. The size of the book is 9 by 12 inches, and in nearly every instance a picture of large size occupies the right hand page. The text is in English, French, and German. The book was issued more particularly as a Paris Exposition number. The Niles Company received a highest award at the hands of the Exposition officials, the Grand Prix. We doubt very much if the catalogue is for general distribution, but probably the inquiries of proprietors and managers of engineering establishments in which machine tools are used will not be overlooked.

The Newton Machine Tool Works, Vine and 24th streets, Philadelphia, Pa., have issued a new catalogue, known as No. 34. It comprises 192 pages, is 6 by 9 inches in size, and is bound in stiff board cover. This company makes a large line of tools for machine shop equipments, such as would be used in shipyards and other engineering establishments. These tools include cylinder boring machines, drill presses, and other drilling machines of many kinds, cold saw cutting off machines, all kinds of milling and shaping machines, slotting machines, etc. The book is most profusely illustrated with unusually good wood cuts, and each machine is concisely described, giving such information as would naturally be sought. Although the catalogue is very elaborate and complete, undoubtedly copies can be had upon application by mentioning MARINE ENGINEERING.

The Simplex lathe center grinder is a most useful little device which is being offered to the machinery trade by Herman Dock, 905 North Carlisle street, Philadelphia, Pa., and which has a 4-page folder devoted to it. This folder is now ready for distribution. A large illustration shows the construction and manner of operating the grinder, and nearly two pages are devoted to a description of it.

The Pittsburg feed water heater and purifier of both open and closed types has a catalogue of 42 pages devoted to it, and to other specialties which are sold by James Bonar, Carnegie Building, Pittsburg, Pa. A number of illustrations are given of the heater, illustrating the various types and sizes, and many testimonials are published, also a list of users, and tables which will be of much interest to engineers. A number of pages in the back part of the catalogue describe other specialities, such as the Bonar oil filter and separator, gauge cocks, etc.

A price list of planimeters and integrators has been issued by the Keuffel & Esser Company, 127 Fulton street, New York city. The descriptive matter is quite complete, and there are many illustrations of different styles and sizes of planimeters and other instruments. Almost every engineer is interested in the subject of indicator work, and would find this price list a most instructive one to peruse.

"Three Points of View" is the title of an exceedingly well printed and attractive catalogue issued by the American Turret Lathe Co., Wilmington, Del. It is printed in two colors, and contains two fine half-tone engravings of this company's lathes, one 24 in. the other 40 in. Several pages are devoted to a description of the lathes, and of their special features. The lathes have been introduced by several of the largest shipbuilding and engineering companies of the country. They have a large number of speeds, a large range of feeds, and many other features which are emphasized in this catalogue. Any user of machine tools will be interested to send for a copy.

Users of grease cups will have an interesting little catalogue sent to them upon application by James L. Robertson & Sons, 218 Fulton street, New York city, descriptive of the Tic-a-toc automatic grease cup. Illustrations are given showing the cup complete and in various positions and conditions. There are also several testimonials from those who have used the cup, together with price lists and other information.

Wearers of overclothes will want to send for a sample sheet of goods issued by Hamilton, Carhart & Co., Detroit, Mich., descriptive of the union made clothing which this company sells. This card contains samples of eight different kinds of goods, which are designed for various garments, such as overclothes of all kinds, coats, shirts, etc. There is also sent with this card to those who wish it a measure a yard long, to use in filling orders by mail. The subject is one which all of our readers who are not satisfied with their overclothes should investigate.

Marine specialties of the Boston & Lockport Block Company, 142 Commercial street, Boston, Mass., are thoroughly illustrated and described in the 1900 catalogue, now ready for distribution. This catalogue is pocketsize, and comprises 112 pages. It is very complete and comprehensive, and should be in the hands of every purchaser, both afloat and on shore. The thoroughness with which it covers the field is shown by the fact that the index covers four pages and includes nearly everything that could be conceived of, and is especially complete in a line of blocks, hoists of all kinds, diaphragm pumps, warehouse and other trucks, mallets, etc. The catalogue is very profusely illustrated, and must be invaluable for purposes of reference and for purchasing supplies. Copies can be had upon referring to MARINE ENGINEERING.

Two exceptionally handsome and instructive catalogues are issued by the Westinghouse Electric & Mfg. Company. One of them is devoted to the subject of electric power. It comprises 136 pages, all of which are neatly printed. Each right hand page has an illustration of some application of electric power, so that the catalogue is really a statement in pictures of the application of electricity by means of Westinghouse motors for industrial purposes. The book was published for distribution at the Paris Exposition, and the brief descriptive matter accompanying each illustration is printed in English, French, German, and Spanish. The catalogue could not fail to be of much value to any one interested in the subject of electric power. The other catalogue is entitled "Drop in Alternating Current Lines." Like the other, it is a choice specimen of the bookmaker's art. The first part of this catalogue treats of a method of calculating the drop in alternating circuits, making it a most valuable one for those who have to do with this form of current. There is also a most satisfactory description of the Westinghouse type F compensator. Copies of either or both of these catalogues can be had upon application to the Publishing Department of the Westinghouse Electric & Mfg. Company, Pittsburg, Pa.

The use of Lundell electric motors where small power is desired is illustrated and described in bulletin No. 201, issued by the Sprague Electric Company, 527 West 34th street, New York city.

The Swain patent lubricator and other specialities for engineers have an 8-page folder devoted to them issued by the New York agent, W. B. Maull, 35 Dey street. The folder has a number of illustrations of the lubricator in addition to the text. Copies will undoubtedly be sent to all inquirers.

The war in China, which has been followed carefully by most readers, is made more understandable by referring to a pocket map of China. A copy one will undoubtedly be sent to all of our readers if they refer to this paragraph, and write to Patterson, Gottfried & Hunter, 146 Center street, New York city.

Two Circulars have been issued by the Consolidated Telferage Company, 20 Broad street, New York city, which refer to this company's system for handling freight of various kinds. This system is designed especially for handling coal, ore, and other cargoes, either when vessels are alongside the wharf or at anchor in the stream.

Yachtsmen and others interested in the subject of pleasure boats of all kinds will undoubtedly have sent to them upon application to A. G. Cuthbert, 92nd street and Calumet River, Chicago, Ill., a 32-page catalogue describing the yachts which this builder has designed and built. The many illustrations add much to the completeness of the catalogue.

"Protection that Protects" is the title of a very dainty booklet issued by the Pittsburg Gage and Supply Co., Pittsburg, Pa. The printing is most neatly done in two colors. The subject matter is the Pittsburg safety water column. The booklet is one that all of our readers would wish to have for its appearance as well as for the value it has in describing the water column and other specialties.

BUSINESS NOTES.

Asbestos Sheathing.—The H. W. Johns Manufacturing Company, 100 William street, New York, has ready for distribution a very interesting article on the subject of asbestos sheathing, as applied to vessels. It refers especially to the use of this sheathing in steel vessels, and in the living parts of the vessels. The subject is very completely handled, and is quite fully illustrated.

Valve Reseating Machines.—Every engineer will appreciate the value of an efficient valve reseating machine, and will be interested in the Standard machine, which is manufactured and sold by W. P. Barnum, Fredonia, N. Y. This machine has recently been made as complete and efficient as it is believed such a machine could be. It reseats all kinds of valves eight or ten times without disconnecting them from the pipes. The machine has great range, in that it will reseat valves from 1-4 in. to 12 in. The manufacturer has such confidence in it that he offers to send the machine on trial, and if it does not do what is claimed for it, it can be returned, and need not be paid for.

Copenhagen Porcelain.—As royal Copenhagen ware is used very extensively on the leading ocean liners, war vessels, and steam yachts, it is interesting to note that the company manufacturing this ware received at Paris the highest award which it is possible for any manufacturer outside of Sevres to receive—a grand prize. The Sevres ware was used as a standard, with twenty points, and the royal Copenhagen received nineteen. The next on the list received only seventeen points. A grand prize was also awarded to the art director, and gold medals to the chemist and the artist of the Copenhagen Company. This ware is sold by the leading dealers in this country. The American headquarters are at 96 Church street, New York, with Mr. Christian Scherfig as manager.

PNEUMATIC TOOLS.—Owing to the great increase in its business, the Standard Pneumatic Tool Company, head offices Marquette Building, Chicago, Ill., has opened a New England office at 185 Summer street, Boston, Mass., under the charge of Mr. F. A. Barbey.

SMOOTH-ON COMPOUND.—Although recently put on the market, the Smooth-on compound is increasing very rapidly in sales, and is now used very extensively on steam vessels, not only in salt water, but in inland waterways. These sales are believed to be due exclusively to the excellent qualities of this compound for repairing leaks and doing other work in finishing iron and steel parts. The Smooth-on Manufacturing Company, 547 Communipaw avenue, Jersey City, N. J., which manufactures the compound, is now distributing a catalogue which gives much information regarding this material.

UNIVERSAL HAND OIL PUMP.—One of the most popular oil pumps which has been on the market for many years is the "Universal," manufactured by the Lunkenheimer Company, Cincinnati, Ohio. This pump is easy to attach, fill, and operate, and it works well under high pressure. It can be attached either vertically or horizontally. The filling hole is closed by a hinged cap, which keeps out dust and dirt. In addition, there is a removable wire gauze strainer to insure clean oil. The plunger is carefully made and very durable. In fact, all of the parts are of ample size, so that the pump shall not easily get out of order.

EDUCATION BY CORRESPONDENCE.—Many a young man with ambition but with lack of facilities for securing a higher education in the ordinary way has fitted himself by means of a correspondence school to hold far better positions than he could possibly expect to hold without technical education. Education by correspondence can be secured readily at small cost, the studying being done evenings and odd hours. In order to still further encourage worthy young men to equip themselves in marine and other lines of engineering, the trustees of the American School of Correspondence, 156 Tremont street, Boston, Mass., have voted to award to ambitious and deserving young man in each of the engineering establishments in the country, a free scholarship. Every reader of MARINE ENGINEERING. who is at all ambitious to earn more money and to hold a better position, should investigate this offer. Our subscribers on the Great Lakes will be interested to learn that this school has opened an office, room 229, in the Arcade, Cleveland, Ohio.

A COMPANY WITH A HISTORY.—Few companies in the country can have more historic associations than has the Taunton-New Bedford Copper Company, New Bedford, Mass. This company is a combination of the Revere Copper Company, the Taunton Copper Manufacturing Company, and the New Bedford Copper Company. The Revere Company succeeded to the business of Paul Revere in the early part of the present century, who won fame early in life by the historic ride at the opening of the Revolutionary War. Revere established his plant for rolling copper in Canton, Mass., about one hundred and ten years ago. The Taunton Company dates back to 1823 when Crocker Bros. began rolling sheet copper and yellow metal. The New Bedford Company was incorporated in 1860, and has funished a large amount of sheathing, bolts, rivets, etc., for the whaling vessels which made the city so famous, and was established at the time when only the very best materials were used, as whaling ships have always been famous for being as staunch as they could be built. It will be seen that the consolidated company has over a century of experience back of it. The business management, however, is as up-to-date as possible. The company makes the strongest of claims for its products, and believes that its yellow (Muntz) metal specialties are the finest in the land. The company makes a specialty of sheathing, condenser plates, bolts, bars, pump rods, and almost everything else that could be asked for in copper or yellow metal.

Safety Valves and Gauges.—The trade in steam specialties will not be surprised to hear that the Ashton Valve Company, 271 Franklin street, Boston, Mass., received at the Paris Exposition awards for its exhibit of pop safety valves and gauges. This company received three medals, one silver and two bronze. The silver medal is the highest award that it is possible to obtain in this class of goods.

Asbesto-Metallic Packing.—The C. W. Trainer Manufacturing Company, Boston, Mass., which manufacturing the well-known Olympia asbesto-metallic packing, has received a letter from a leading concern in which the statement is made that this packing is too serviceable. "We hear nothing but good words of it, where we have sent it out, but it does not wear out fast enough for us to give you many orders."

Heintz Steam Traps.—In equipping the yard of the New York Shipbuilding Company at Camden, N. J., a large number of Heintz steam traps were purchased from the W. S. Haines Company, 136 South Fourth street, Philadelphia, Pa. These traps are equally well adapted for marine and stationary uses. A special feature claimed for them is that they act very effectively even if there is considerable back pressure.

The Besly Specialties.—Charles H. Besly & Company, 10 South Canal street, Chicago, Ill., report a very extensive trade, particularly east of Chicago, for their parallel clamps. These are of all styles, are case hardened, and all surfaces are either parallel or at right angles to each other. They have become extensively used in nearly all of the leading machine shops. No more complete catalogue is issued than by this firm, and any reader who is an engineer or a mechanic in any line will want to have a copy of this catalogue at hand for reference. It is sent upon application without charge.

Water Tight Compartments.—The Long-Arm System, Cleveland, Ohio, which makes a specialty of manufacturing water tight compartments for vessels of all kinds, has found it necessary to increase its facilities and has established its offices in its new factory and warehouse at the corner of Lake and Wason streets, Cleveland, Ohio.

American Auxiliaries.—The new French Transatlantic steamer *La Lorraine*, which has just been put into commission, and which has made one or two trips, has a complete outfit of Blake vertical system pumps, furnished by the George F. Blake Manufacturing Company, 91 Liberty street, New York. These include air pumps, simplex face pumps, hot well lift pumps, bilge pumps, ballast pumps, etc. During the few trips which the steamer has made, this equipment has done great credit to its manufacturers. The sister ship, *La Savoe*, will have a similar equipment of Blake apparatus.

Export Trade.—The rapid growth of the export business of the B. F. Sturtevant Co., Jamaica Plain, Mass., manufacturers of blowers, heating and drying apparatus, engines, forges, electrical equipment, etc., is well exemplified by recent foreign orders for forges which aggregate 200 for Japan, 75 for Russia, 40 for Germany, 32 for Canada and 24 for Sweden, in addition to large numbers distributed through its London and Continental stores. Domestic demands have likewise increased in the same line during the past few months, large forge equipments having been furnished to several ship building and locomotive shops in the United States. The manual training, trades and technical schools have also been placing some large orders with this company. The town of Boulder in the new gold fields of West Australia was recently equipped by the Sturtevant Co. with generating sets for lighting and power purposes.

Willamette Iron and Steel Works.—The consolidation of the various shops of the Willamette Iron and Steel Works, at Portland, Ore., has been effected, the establishment now covering a block of property in the heart of the city, with railroad shipping facilities of the Northern Pacific Terminal Co. Many new tools have been installed, and the machine shop brought up to a high state of efficiency. The old Willamette Iron Works, to which the new establishment is successor, was engaged largely in marine work, and probably a majority of the equipments of the various local river steamers was furnished by these works. A peculiar feature of the work on the Pacific Coast is the great variety of work which is handled. Distances to eastern points are so great that the owners of almost every description of machinery prefer to have repairs and alterations made locally, and a variety of inventions is manufactured locally under patent rights. Recently, for instance, there were five different types of boilers under construction at these works, ranging from the ordinary Scotch marine boiler to the latest water tube boiler.

STEAM CARRIAGES.—Those of our readers interested in automobiles will find much to attract their attention in a circular issued by the Peerless Long Distance Steam Carriage Company, Washington, D. C., describing the steam outfit which this company uses in its automobiles.

EUREKA PACKING.—James L. Robertson & Sons, 218 Fulton street, New York city, have issued some little slips regarding Eureka packing which emphasize the fact that this packing outwears expensive packings, that its cost is less than most packings, that it has a flat core, giving elasticity, that the braided flax yarn gives strength, that special lubricants are worked in during the braiding, giving lubricating qualities, and finally, that Eureka is a good packing.

A FINE COMPLIMENT.—Among the exhibits at the Paris Exposition which have attracted widespread attention is a model of the Broadway Chambers Building, New York city. The constructor writes to the Bullock Electric Company, St. Paul Building, New York, which furnished the electrical outfit, as follows: "Your dynamo forms a prominent feature in our exhibit, and helped to obtain the grand prize and gold medals which have been awarded to this exhibit." The Bullock Company furnishes a very complete line of descriptive and illustrative bulletins on electrical subjects, copies of which are sent free upon application.

THE MORSE DRY DOCK COMPANY'S NEW PLANT.—In a recent issue, one of the local papers of Brooklyn, N. Y., has a description of the new plant being established by the Morse Iron Works Company, from which the following is taken: "The mammoth dock is in course of construction at Bay Ridge, between Fifty-fifth and Fifty-seventh streets, taking in an area along the water front of nearly two blocks. The dock is merely one feature of an extensive and thoroughly up to date ship repair yard now being laid out and constructed by the Morse Company. The land which the company is to use for the purpose extends a distance of 426 ft. along the water front. Besides the dry dock, which is to be a floating one, there is to be a wet dock or basin. The first 700 ft. of the basin will be about 37 ft. wide with a depth of 25 ft., and here vessels with a moderate draft will be berthed in the proximity of the machine shop. The outer 700 ft. of the channel will be 100 ft. wide and will have a clear depth of 35 ft., or sufficient to accommodate the largest ocean liners. The frontage of the three piers will aggregate 4,000 ft., and each pier will be traversed by a railway which will run through the boiler and repair shops, and also have connection with other points in the yard. At about the midlength of the southerly pier there will be a large coal pocket for the accommodation of the ships which visit the basin. Immediately to the east of the dry dock basin will be a boiler shop, and beyond this a large two-story machine and repair shop, the width of each of these buildings being 80 ft., and their combined length 600 ft. The machinery will be in every way up to date. Electric power will be extensively employed, most of the machines being run by direct connected motors, and extensive use will be made of compressed air, not only in the shop, but throughout the yard. The company estimates that it will be able to accommodate about twenty-five ships, big and little, at one time in the dry dock and the adjoining basins."

ELECTRIC POWER.—The contract has been awarded to the Sprague Electric Company, 527 West 34th street, New York city, to equip a plant of the Dunmore Steel & Iron Company, Dunmore, Pa., with electrical power. The preliminary order calls for two split pole generators and fifty motors.

LUMBER FOR SHIPBUILDERS.—Among the concerns which make a specialty of handling lumber for shipbuilders is Charles Esté, whose yard is at Twentieth street and Glenwood avenue, Philadelphia, Pa. Mr. Esté handles everything in the line of lumber, and makes a specialty of decking and of teak. He supplies everything that a ship or yacht building establishment needs in the line of wood.

INSTRUCTION BY CORRESPONDENCE.—One of the most profitable post offices in the United States is that at Scranton, Pa. The volume of business is unusually large, and is steadily increasing, the figures for the first six months of the present year showing more than double the business for the same months in 1893. This is due principally to the rapid growth of the International Correspondence Schools. Seven years ago the Schools' postage was barely five per cent of the total, but now one-third of Scranton's postage is paid by the International Correspondence Schools. Their postage has increased from an average of less than $400 to over $5,000 a month.

Ashcroft Specialties.—The Ashcroft Manufacturing Company, 87 Liberty street, New York, was awarded a medal at the Paris Expsition for the best steam gauges.

Proof Test for Chains.—The Jenkins Iron & Tool Company, Howard, Pa., issues a slip regarding the chains which it manufactures, giving a series of proof tests. It furnishes a safe working guide for the use of chains. Different sizes of chains are given, from 3-16 in. to 1 3-4 in.

Instruction in Chemistry.—The International Correspondence Schools, Box 1111, Scranton, Pa., have found it necessary to establish a special course of instruction by mail in chemistry. It includes mathematics, physics, theoretical, inorganic, and organic chemistry, qualitative and quantitative analysis.

The Lee Injector.—The Lee Injector Manufacturing Company, Detroit, Mich., carried off honors at the Paris Exposition in being awarded a diploma and a silver medal for the Lee ball valve automatic injector. These injectors were doing active duty in the American exhibit, therefore the award was based upon practical operation. These injectors are particularly adapted to marine work. The engineer of the new Harvard coaching launch writes: "It works perfectly satisfactorily, from 40 to 265 lb. steam feeding through two heater coils containing 222 1-2 ft. of 3-4 in. pipe each, before entering the boiler proper."

Bethlehem Steel Company.—The Bethlehem Steel, Co., 100 Broadway, New York city, has received orders for spare propeller shafts for the steamers *Ponce* and *San Juan*. This company is also supplying a large number of hollow shafts of fluid compressed open hearth steel, and also of nickel steel for many large plants. The new propeller shaft to replace the broken one in *La Grande Duchesse* was ordered by telegraph. This was of fluid compressed open hearth steel. Although it weighed over 15,000 lb. the shaft was delivered five days earlier than the requirements called for. A justice in a British Admiralty Court recently stated that the courts have awarded $675,000 for salvage of steamers crippled on account of broken shafts within two years, and only $475,000 for salvage due to all other causes. This emphasizes the necessity of having a thoroughly reliable shaft.

Bermuda Floating Dock.—At the yard of Swan & Hunter, on the Tyne, England, preparations are being made for the construction of the large floating dry dock for the British navy yard at Hamilton, Bermuda. In the Naval Works Bill, the British Parliament last fall authorized the construction of this dock, the old dock at Bermuda not being of sufficient capacity to handle the modern vessels. Plans for the dock have been prepared by Clark & Standfield, of London, who also made the drawings for the U. S. dock for Algiers, La., now under construction at the Sparrow's Point yard, Maryland. The contract price for the new Bermuda dock is $925,000, and it is to be completed and the acceptance trials finished in time to allow the dock to be towed to its destination in August, 1901. The dock is of these dimensions: Length over blocks, 545 ft.; breadth, 100 ft.; depth over blocks, 33 ft.; maximum lifting power, 17,500 tons. The dock will be constructed with three pontoons. When exerting its maximum power the floor will come 15 in. below the surface, necessitating the use of light gates at the ends. In this respect, the Bermuda dock differs from the U. S. Algiers dock, and there are differences also in the methods of supporting the vessels on the docks. As fresh water is scarce at Hamilton, the upper deck will be laid with teak, cambered to collect the rain water. The pumping plant for handling the dock will be in duplicate, and will be driven by compound condensing engines, steam being supplied by boilers of the ordinary marine return tube type. For protection against the coral which forms the bottom of Hamilton harbor, the underside of the pontoons will be protected by six keels of 9 in. by 9 in. timber.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

PROFESSIONAL CARDS.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

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This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St, Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN McCLURE, 54 High St., E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
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" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS Tompkinsville, S. I., New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich.
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD McMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. McCARREL, 8 Vernon St, Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W Superior St, Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St, Detroit, Mich.
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" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta, Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, Ave. A, Atlantic City, Norfolk, Va.
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H. HALL, Box 512, New Berne, N. C.
" 104, J. H BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

"The Only Way" to maintain fire under a boiler is illustrated in a 4-page folder issued by the Underfeed Stoker Company of America, 218 La Salle street, Chicago, Ill. The illustrations refer to stationary work, but similar results have been obtained on tug boats in Chicago and elsewhere.

A new steam dock capstan is being put on the market by the Browning Engineering Company, Western Reserve Building, Cleveland, Ohio. Bulletin No. 500, which has just been issued, describes this capstan. The bulletin comprises 12 large pages, and contains many illustrations showing the working parts of the capstan, and giving much information regarding its construction and operation. These capstans are being used on the Great Lakes with much success, and will undoubtedly interest many of our readers.

"Life Preservers" is the title of a catalogue issued by D. Kahnweiler's Sons, 439 Pearl street, New York. This is a business established in 1872, which, as stated in this catalogue, is devoted exclusively to the manufacture of improved life preservers, metallic life rafts, metallic and wooden life boats, and life saving appliances of every description. This firm also manufactures cork cushions, a line of fenders and other similar devices. Full information and copies of the catalogue can be had by referring to MARINE ENGINEERING.

Syphons, jet pumps, injectors, and other specialties manufactured and sold by the Tranter Davison Manufacturing Company, 105 Water street, Pittsburg, Pa., are described in a pocket size catalogue just issued. The jet pumps have been used to a large extent in pumping bilge water and for other purposes. They are fully illustrated and described, and full information given regarding sizes, gallons pumped per hour, etc. The jet pumps are also fully described and illustrated. Copies of the catalogue are sent upon application.

Users of woodworking machinery should send to Baxter D. Whitney, Winchendon, Mass., for a sample of curly maple, to show the quality of work which is done by the Whitney wood scraping machine. As stated on the sample, it is a specimen of the work of this machine, which is fed at the rate of 75 lineal feet per minute. A very neatly printed and well illustrated 8-page folder will be sent to inquirers. A number of illustrations add much to the value of the circular. This circular will be especially appreciated by any one who has to do with fine cabinet work or interior finish of any kind.

Steam Specialties manufactured by the Pittsburg Gauge & Supply Company, Pittsburg, Pa., are described in a very handsome and complete catalogue which is now ready for distribution. It comprises 50 pages, and has a complete index. The printing is exceptionally good, and the illustrations are numerous. The specialties include safety water columns, feed water regulators, gauge cocks, blow-off valves, gauges of all kinds, oil filters, boiler tube cleaners, engine clocks, thermometers, etc. The catalogue is one which every one of our readers interested in the subjects should have on hand for reference.

Draughtsmen and business men and others who wish pens, ink erasers, penknives, etc., which are suited to their own wishes, should send for a catalogue covering these specialties issued by the Miller Bros. Cutlery Company, 309 Broadway, New York. A hundred or more different styles, sizes and kinds of pens are illustrated, including a full line of draughtsmen's pens for red ink as well as black and other inks. There are also many pens for special work, such as carbon manifolding, etc. There are about twenty-five different styles of ink erasers illustrated, with a variety of different styles of blades, also a full line of penknives especially designed for the draughting table and the office desk.

The Pittsburg riveting machines, manufactured by Chester B. Albree, Allegheny, Pa., have a 48-page catalogue devoted to them. The many types of riveters are illustrated, and the catalogue contains in addition a description of each of these, together with considerable information regarding the subject of mechanical riveting, tables regarding rivets, etc.

The George E, Dow Pump & Engine Company, First and Natoma streets, San Francisco, Cal., has issued a very complete catalogue of its steam and power pumps. The catalogue is handsomely published, comprises 112 pages, with a complete index. The illustrations are very numerous, and altogether the catalogue is very complete and comprehensive.

"Object Lessons in Vertical Milling Machines" is the title to a most useful book issued by the Becker-Brainard Milling Machine Company, Hyde Park, Mass. The booklet is designed to teach some of the advantages of the Becker vertical milling machine in general practice. A number of illustrations add much to the value of the booklet in that they show the working of the machines under various conditions.

Probably no more complete and comprehensive a catalogue has ever been issued than the one which is just being sent out by Manning, Maxwell & Moore, 85-89 Liberty street, New York. Heretofore the catalogue of this company has been one of the wonders in the trade, but everything has been included in one volume. This year the company has found it necessary to issue two volumes, the first of which is now at hand and which is devoted exclusively to metal working and wood working machine tools and other attachments. It comprises over 700 pages in imperial quarto and is bound in stiff board. The volume is most profusely illustrated with every conceivable variety of machines and tools, and accompanying each specialty are tables of sizes, dimensions, etc., and concise descriptive matter. The illustrations are designated by numbers and the arrangement is such that orders can be sent by telegraphic code without difficulty. The book is 10 to 13 inches in size, and some idea of its comprehensiveness will be gained when it is stated that the index to the contents covers six pages, three columns to the page. This company has a large store in Chicago, 22-26 South Canal street, where a full stock of tools and machines is carried; also an office in Pittsburg in the Park Building, and one in Cleveland, in the Willamson Building. The main office in New York occupies an immense floor space, and outside of this there are three large warehouses filled with machinery for prompt delivery. Such an expensive catalogue can hardly be for general distribution, but we have no doubt that any shipbuilding or engineering establishment which has use for machine tools of any kind will be able to secure a copy by mentioning MARINE ENGINEERING.

Electrical trolley hoists and traveling cranes are illustrated and described in an exceptionally neatly printed 4-page folder issued by the Sprague Electric Company, 527 West 34th street, New York, as bulletin No. 203. The usefulness of these hoists in shipyards, warehouses, and elsewhere is explained in the text.

Acetylene gas generators manufactured by the J. B. Colt Company, 404 East Thirty-second street, New York, have been introduced on a considerable number of yachts and other vessels during the past year or two. This fact will add much interest to the catalogue issued by the company describing the generators. A number of illustrations show the different types and sizes of plants, and the descriptive matter is exceptionally complete. Considerable attention is also given to the subject of acetylene burners and of searchlights. These lights have great power, and are easily applied to any boat or vessel which has an acetylene plant.

Steam regulating devices and steam pumps manufactured by the Mason Regulator Company, 6 Oliver street, Boston, Mass., have had a new catalogue just issued regarding them. It is a pocket size edition of 40 pages, very fully illustrated, particularly with sectional views of many of the specialties. Among the specialties of interest to marine people are steam pumps of many types and kinds, reducing valves of several kinds, by-pass valves, etc. Copies can be had upon application.

Boilermakers' and shipbuilders' machinery in great variety is fully illustrated and described in a complete catalogue just issued by the Cleveland Punch & Shears Works Company, Cleveland, Ohio. The book comprises about 70 large pages, and a number of supplementary sheets. The tools shown include a full line of punches, shears, radial drills, rotary planers, bending rolls, plate straightening rolls, hammers, presses, etc. Any one who has to do with shipbuilding, boiler, tank, or engine work, will find a copy of this catalogue a most valuable one for reference. Nearly all of the illustrations are full page size.

Users of lanterns and signal lamps of all kinds will be interested in the new folder just issued by Russell & Watson, Buffalo, N. Y. A line of lanterns is illustrated in this folder, and the special features of the fluted lenses used are referred to. Any user of lamps will undoubtedly have sent to him a sample showing the construction of these lenses upon application.

"As Others See Us" is the title to a 50-page booklet issued by the H. W. Jones Manufacturing Company. On each left hand page is a letter from some concern or shipbuilding company which has used the Johns asbestos roofing or other asbestos product. Pictures on the right hand pages add much to the interest and value of the booklet, as they show the variety of manufacturing establishments, steamboats, and other structures upon which the materials have been used.

The Flinn differential steam trap is now being manufactured and sold by the Harrison Safety Boiler Works, Philadelphia, Pa., which have just issued a neat and complete catalogue regarding this trap. The trap has already been put into use on many steam vessels, both in the government service and merchant marine, and its construction is such that it is especially adapted to marine work. The caealogue shows a number of illustrations and gives much information which users of traps would want to know.

The subject of steel and wooden steamboats, side wheel and stern wheel, is covered very fully in the catalogue just issued by the James Rees & Sons Company, Pittsburg, Pa. It comprises nearly 50 pages, and there is an illustration to nearly every page. These pictures show typical river boats which have been built by this company for use on the Mississippi and Ohio Rivers and other waters, for both freight and passenger service, and they include boats of all draughts, some of which are only about 18 inches. A few propeller boats, mostly of light draught, are also shown. The catalogue is of much interest in that it shows a distinct type of boat which has been developed to a greater extent in this country than in any other part of the world.

Draftsmen and others who make any use of drawing materials, mathematical and surveying instruments, will have sent to them upon application the thirtieth edition of the catalogue issued by the Keuffel & Esser Company, 127 Fulton street, New York, if reference is made to MARINE ENGINEERING. It is a volume of about 500 pages, or 50 pages more than the preceding edition. The extra pages were necessitated by the addition of a number of new specialties, and by the elaborating of some descriptions. The index is particularly complete and a most valuable one for references. In this catalogue much new matter is given on the subject of slide rules, planimeters and pantographs. Fine, narrow steel tapes are also given much more attention. There is also much information on the subject of current meters, tide gauges, aneroids, thermographs, sextants, octants, etc.

A paint for protecting iron and steel surfaces is described in a folder issued by the Joseph Dixon Crucible Company, Jersey City, N. J. It refers to Dixon's silica-graphite paint.

Two catalogues are just issued by the International Correspondence Schools, Box 1,111, Scranton, Pa. One is devoted to a description of the school of mechanical engineering, the other to electrical power and light.

A catalogue of machine tools for working plates, shapes, and bars is issued by the Hilles & Jones Company, Wilmington, Del., and known as Catalogue Q. The catalogue is about 9 inches square, is printed on heavy coated paper, and comprises 24 pages. It has from two to four pictures to a page. The several machines illustrated include punches and shears in great variety of size and shape, together with bending and straightening machines, planers, bending rolls, etc.

The B. F. Sturtevant Company, Jamaica Plain, Mass., has found it necessary to issue a second edition of Catalogue No. 101, which is devoted to the subject of steel plate planing mill exhausters. Those of our readers who did not secure a copy of the first edition may now be supplied. A second edition has also been issued of Bulletin S. describing the Sturtevant four-pole motors and generators for direct current.

Users of trucks and wheelbarrows will be interested in a large four-page folder issued by Pugley & Chapman, 180 West street, New York. This folder contains a large number of illustrations of trucks of all kinds, such as would be used on steam vessels and wharves for handling baggage, freight, etc. Many wheelbarrows of the type used for handling coal and other freight are illustrated. There are also other articles illustrated of interest to marine people, such as portable forges, galvanized fire buckets, etc.

BUSINESS NOTES.

Lubricating Oils.—During the recent automobile exhibit in Chicago we are informed that many owners of automobiles and representatives of automobile concerns specially requested Charles H. Besly, 10 North Canal street, Chicago, to send a can of Helmet oil and some Bonanza oil cups, as each "wanted to win the race." These and the many other specialties of this firm are fully described in a handsome catalogue a copy of which is sent to all inquirers.

A Fine Yard.—In a recent letter the Greenport Basin & Construction Co., Greenport, L. I., writes: "We are about to launch a set of railways the equal for size of any on the coast. The cradle will haul a 175 ft. yacht or vessel and we can get at any stage of the tide 18 ft. of water. We have also begun to increase the size of our yacht basin and when completed will be able to store yachts drawing 15 to 22 ft. of water. We have built a new storehouse far yachts' goods and believe we have one of the finest storage spots on the coast. Our new railway is provided with 2 1-4 in. chain; the gears of the engines have been supplied by H. I. Crandall & Sons, Boston."

Improved Die Plate.—The Crane Company, 10 North Jefferson street, Chicago, Ill., is introducing the Crane adjustable die plate. It is a very simple tool, made of malleable iron, and has the fewest possible number of parts. These parts are all made interchangeable. The cutting off tool has been discarded, although it can be bought separately for a nominal price if desired. The leader screw has been adapted as a substitute, as this is believed to be indispensable to the easy and correct working of large dies. A complete description with illustrations of this tool are found in the pocket catalogue, a copy of which will be sent by the Crane Company upon application.

YACHT HARDWARE.—Owing to the large increase in its many specialties, the concern formerly known as the Enos Sheet Holder Company, Peabody, Mass., has changed its name to the Marine Hardware Company. This company will manufacture a complete line of windlasses and winches for yachts and small vessels, brass and bronze marine hardware, light and heavy brass castings, etc.

CORK TILING.—The Cork & Floor Tile Company, 139 Congress street, Boston, Mass., has its cork tiles specified on the three new tramp steamers building at the Maryland Steel Company's plant for the Boston Towboat Company, having recently completed two large tile jobs on the steamers *Hyades* and *Pleiades*. Among the recent contracts in hotels, this company has secured the contract for laying cork tiles in the new dining room of the Atlantic Hotel, Bridgeport, Conn., and is laying tiles on the International Navigation Company's steamer *Waesland*.

TWO GRAND PRIZES.—The John A. Roeblings Sons Company, Trenton, N. J., secured two grand prizes at the Paris Exposition. One prize was for wire one-one thousandth of an inch in diameter. One mile of this wire weighed a quarter of an ounce. The exhibit included wire of all kinds, from this up to samples of cables used on the Brooklyn Bridge. In addition to the two grand prizes, the company received two gold medals. The second exhibit of the company was a full line of electrical trolley tracks and wires. A feature of the exhibit which attracted much attention was an exact model of the Brooklyn Bridge. Owing to the great increase in its trade, this company has very largely increased its manufacturing capacity, and has built a complete wire mill, which is probably the most extensive single mill in the world.

AN ISLAND SHIPYARD.—The Townsend & Downey Shipbuilding Company, office Produce Exchange Annex, New York city, now has in full operation its shipyard on Shooters' Island, Newark Bay, New York harbor. There are 43 acres of land within the lines of the company. The wharfage basin is 1,100 by 550 ft. The draft of water is 20 to 25 ft. at low water. The machine shop is 200 by 90 ft., and is a new steel building, equipped with all modern appliances, including a 30-ton electric crane. The blacksmith shop, 120 by 60 ft., is equipped with 17 forges, steam hammer, etc. The sawing and planing mill is 225 by 60 ft., and is furnished with all modern mills and tools, together with woodworking machinery, capable of doing any work, from the heaviest to fine cabinet work. The plate and angle shop is 200 by 80 ft., and is equipped with complete angle furnaces, bending floors and heavy machinery and tools for iron and steel shipbuilding. All of the machinery is driven by electric power. The mold loft is 245 by 75 ft. The company owns a 93 ft. waterfront and wharf 800 ft. long at Mariners' Harbor, directly opposite the works on the shore of Staten Island. The company also owns and operates it own ferry boat between the works and Staten Island. At present it is the side wheeler *Edmund Butler*. This boat was hauled out by fast gear in twelve minutes from the time it was centered on the new marine railway, no doubt a record time. The steamship *North Sands*, 3,526 tons burden, with 550 tons of water and 400 tons of coal in her, was hauled up on this marine railway in twenty-nine minutes from the time she was centered on the keel blocks. There are two speeds at which the machinery can be run, one being twice as fast as the other. The *North Sands* was hauled up at slow speed, to guarantee absolute safety. The company is now building a twin screw hydraulic dredging ship for the U. S. War Department for use at Sabine Pass. Delivery of this vessel will be made in the middle of December. The company is also building a barge for the Tidewater Oil Company. The company has recently been awarded a contract by the U. S. Government for a composite ship to replace the coast survey vessel *Bache*.

Kenney Flushometers.—The flushometer manufactured by the Kenney Company, 72 Trinity place, New York, which has met with much success in marine work, has been adopted in one of the largest office buildings in the country, which is being built in New York, on the corner of Broad street and Exchange place.

Boilers for Steam Yacht Electra.—The Almy Water Tube Boiler Company, Providence, R. I,, recently received an order and has just filled it for four boilers for the steam yacht *Electra.* These boilers will have 115 sq. ft. of grate surface, and 4,000 sq. ft. of heating surface. They occupy the same place as the See water tube boilers, which have been removed to make place for the Almy. We are informed that there is an increase of 600 ft. in the heating surface and of 41 ft. in the grate surface. This is the third set of boilers in this yacht, as she originally had Scotch boilers.

Pneumatic Drills.—Dunlap & Plum, Columbus, Ohio, manufacturers of pneumatic tools, up to the present time have limited themselves to the manufacture of pneumatic drills. In a recent test we are informed that one of these drills cut a 1 1-4 in. hole through 5 ft. of steel in four hours. This time included the necessary delays, etc.

Johns Asbestos Specialties.—The H. W. Johns Manufacturing Company, 100 William street, New York, has been awarded the contract for the asbestos fire felt covering for boilers, steam pipes, and brine pipes for a large brewery to be built in Havana. The work is done by the company's own men, who are sent down for the purpose. In this connection it is interesting to call attention to the booklet which is sent by this company upon application describing the several asbestos specialties. It refers to the Johns Asbesto-Metallic Kearsarge cloth wound packings and other goods.

THE MAYO LIFE BOAT.—The Rescue Life Boat Company has been organized at Muskegon, Mich., to manufacture life boats under the patents of Captain R. D. Mayo. The boat is described as follows: It consists of a metallic cylinder 30 feet long, with rounded ends. The diameter at the middle is six and one-half feet. The seats are so arranged that no matter how the boat tosses and rolls they are always at the bottom. Air is provided for the occupants by a pipe. The life boats will lie on the deck of a vessel, and when an accident occurs the passengers and crew enter through a man-hole, which is closed from the inside. If the ship sinks the lifeboat remains on the surface. A boat to accommodate 50 persons will cost $600. It is announced that four of these boats have already been ordered by the Barry Transportation Company, of Chicago.

THE NEW RISDON YARD.—The Risdon Iron Works, San Francisco, have recently purchased the property of the old Pacific Rolling Mill Company in the Potrero, San Francisco. This property consists of some 32 acres of ground, immediately adjoining the Union Iron Works, and has a deep water frontage of over 1,700 feet. Application has been made to the Board of State Harbor Commissioners for site for a new dry dock. This dry dock will be 500 feet in length by 100 feet in width. New wharves are now in course of construction. Several new steel frame buildings are contemplated and large orders covering the structural materials for the following buildings have recently been placed: Machine shop, length, 308 feet; width, 100 feet. Total lift over main floor, 45 feet. Boiler shop, length, 140 feet; width, 180 feet. Total lift over main floor, 40 feet. Machine and ship blacksmith shop, length, 300 feet; width, 60 feet. Foundry, length, 177 feet; width, 160 feet. Ship joiner shop, length, 140 feet; width, 81 feet. The machine shop will be equipped with four electric traveling cranes of the following capacities: One 50 ton, one 20 ton, one 15 ton and one 10 ton capacity. Each crane will be of the most modern type and equipped with five ton auxiliary hoists. The boiler shop crane equipment will consist of one 60 ton; one 20 ton and one 10 ton electric traveling crane, each equipped with 5 ton auxiliary hoists. The foundry crane equipment will consist of one 30 ton and one 20 ton electric traveling crane with five ton auxiliary hoists. The ship blacksmith shop will be equipped with eight jib cranes of five and ten tons capacity each. The machinery equipment throughout will consist only of the most modern tools. The entire plant, with the exception of the steam hammers in blacksmith shop, will be operated by electricity. Direct current will be used for the cranes and alternating current for the machinery equipment. Separate motors will be installed in each department. The cost of electric power for operation of this plant for the first year will amount to over $30,000. Risdon representatives are now in Washington preparing estimates for the new battleships for the United States Navy.

Asbesto-Metallic Goods.—The C. W. Trainer Manufacturing Company, 89 Pearl street, Boston, Mass., which manufactures Olympia asbesto-metallic goods, is in receipt of a letter from the chief engineer of the Edison Electric Illuminating Company of Boston, stating: "I have used your Olympia asbesto-metallic woven sheeting with complete success. The woven tape is the finest thing for steam chest joints I have ever used. I have run 125 days on your letter B square piston rod packing, which is good work for soft packing, with a steam pressure of 160 or 170 lbs."

Union Made Overclothes.—Ten years ago Mr. Hamilton Carhartt established a small shop on one of the most unsightly places in Detroit, Mich., for the purpose of making overclothes. He determined to make all his employees as comfortable as possible, so that there should be no reason for their work not being of the best quality. With small beginnings, the plant has now developed into a fine large one. The buildings are of brick, surrounudedby lawns, in which are flower beds, shrubbery, etc., and all the work rooms are light and airy. Knowing the dangers which lurk in sweatshop clothes, Mr. Carhatt went to the other extreme to avoid these dangers. The entire basement of the main building is fitted up with dressing, toilet and wash rooms, and in all the work rooms, although space is economized, there is no unlue crowding. As the noon interval is short, the employees take lunch with them, and tea and coffee are served by the management. The employees number nearly 600, of whom far he largest proportion are girls. They constitute almost the entire membership of local union No. 74, United Garment Workers of America. The factory is run under an agreement between employers and employed, by which the union standard of wages is accepted and provision made for arbitration in case of any want of accord between the parties to the agreement. The employees are treated as though they were assistants to their employers, and therefore take much interest in their work. They have business meetings twice a month, and occasional social functions besides, which relieve the monotony of life, and promote acquaintance, and they feel that if they ever have ground for complaint they have an orderly way of making their grievances known. As a matter of fact, however, they have never had occasion to appoint a committee on grievances, and have never had any complaints to make. Regarding the garmens of the firm, a recent circular says: "No manufacturer can duplicate the goods that we make at a less price and give the same fit, finish and fabric, unless he beats his employees or his creditors. Our business, approaching half a million, built up almost in a night, is not the result of any 'gold brick' scheme, but of good honest values first, last, and all the time. In our apron overalls we put four more yards of fabric to the dozen, and in our waist overalls, coats and shirts two more yards of fabric to the dozen than any of our competitors, and these facts we can easily prove to any one interested. And mind you, we do not consider any manufacturer as a competitor who is ashamed to look his employees in the face on pay day. We confine the sale of our goods to one merchant in each section where the trade will warrant, and advertise and push them in every legitimate manner. Our business is not the largest, never was and probably never will be; but it is large enough to secure all the advantages possible in purchases, and not too large for us to lose sight of our customers' interests. We have never made an effort for quantity. Superior quality is the goal of our ambition. We have honest competition, and do not claim to possess all the manufacturing ability extant, but we feel sure that we are unexcelled in our particular line. Our business is manufacturing men's working garments and nothing else. Our consant study is not how cheap, but how good. Doing an exclusive business in our line, we have some facilities for this study, and have acquired some 'know how.'"

Geipel Steam Traps.—The Geipel steam trap received the highest award at the Paris Exposition. This trap is manufactured by Thorpe, Platt & Co., 99 Cedar street, New York. A 6-page folder is issued by this firm, which illustrates the trap and explains fully its general construction and its many features.

Sprague Electric Company.—At the recent meeting of the board of directors of the Sprague Electric Company, 527 West Thirty-fourth street, New York, the following officers were elected for the ensuing year: John Markle, president; Edward C. Platt, first vice-president; Allan C. Bakewell, second vice-president; Charles P. Geddes, secretary; H. R. Swartz, treasurer and assistant secretary. Owing to the great increase in its business, the Sprague Company has found it necessary to open a branch office in the Security Building, St. Louis. Mr. C. B. White, who has had many years of experience in electrical work in the West, will have charge of this office. The Sprague Company now has branch offices in Boston, Chicago and St. Louis, and agencies in nearly every one of the principal cities in this country and throughout the world.

Correspondence Instruction.—Ambitious mechanics who desire to obtain better positions and higher wages should investigate the advantages afforded by the corrrespondence method of instruction in the theory of trades and engineering professions. Without leaving home or losing time from work, the student pursues a thorough course of study under the direction of able instructors who are always ready and willing to assist him. Instruction papers, prepared especially for teaching by mail, are furnished free. In addition, special information regarding any difficulties in their studies is furnished students without extra charge. A mechanic with practical experience supplemented by theoretical education can command a better position than a man without such an education. The result of long experience in teaching by mail shows that no other method so fully meets the requirements of men who have but little time for study. Full information regarding the many courses in the International Correspondence Schools, Box 1111, Scranton, Pa., can be had free upon application.

MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Established 1874.

NATIONAL OFFICERS.

GEO. UHLER, National President,
1609 Brown St., Philadelphia, Pa.

FRANK A. JONES, National Vice-President,
1616 La Fayette St., Alameda, Cal.

GEO. A. GRUBB, National Secretary,
1318 Wolfram St., Lake View, Chicago, Ill.

ED. R. BLANCHARD, National Treasurer,
583 Fort St. E., Detroit, Mich

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JOHN McG. STERRITT, 129 Broad St.,	New York, N. Y.
JAMES H. TAYLOR, 1513 Jefferson St.,	Baltimore, Md.

This Association limits its membership to licensed and commissioned marine engineers and has the local associations in the various parts of the country given below. Delegates from each local association meet in January each year in annual convention and for the election of officers.

ADDRESSES OF CORRESPONDING SECRETARIES.

No. 1, ROBT. A. NOONE, 498 Swan St., Buffalo, N. Y.
" 2, JOHN B. HEYWARD, 191 Willard St., Cleveland, O.
" 3, JOHN MCCLURE, 54 High St., E. Detroit, Mich.
" 4, JAS. A. MACAULEY, 5902 Michigan Ave., Chicago, Ill.
" 5, HARRY P. WALKER, 418S. Patterson Park Ave., Baltimore, Md.
" 9, WM. BRIDGES, 784½ 12th St., Milwaukee, Wis.
" 13, SAM'L M. HALL, 2232 S. 5th St.. Philadelphia, Pa.
" 15, of New Orleans, La., ALFRED BIRKS, 315 Atlantic Ave., Algiers, La.
" 17, JOHN H. HOWE, 316 Vine St., Cincinnati, Ohio.
" 18, SAMUEL SHOEMAKER, 9th St. bet. Washington and Commercial, Cairo, Ill.
" 24, JOS. M. ST. JOHN, 223 South First St., Paducah, Ky.
" 27, N. P. SLATER, 1010 Garfield Ave., Bay City, Mich.
" 30, JOHN W. FARROW, 427 Pearl St., Pittsburg, Pa.
" 33, W. J. DU BOIS Tompkinsville, S. I.. New York.
" 35, WM. WARIN, 36 East St., San Francisco, Cal.
" 36, JOSEPH THOMAS, 57 Sea St., New Haven, Conn.
" 37, E. D. LOCK, 1304 S. 19th St., Toledo, O.
" 38, W. H. COLLIER, 73 Starr Boyd Building, Seattle, Wash.
" 39, FRANK W. BUCHNER, 124 Chestnut St., Erie, Pa.
" 40, H. N. POWELL, 1626 Ave. N½, Galveston, Tex.
" 41, J. W. COLLYER, Goble, Columbia Co., Ore.
" 43, GEORGE A. MILLER, 828 Wall St., Port Huron, Mich.
" 44, CHRIST DAHL, 534 W. 2d St., Manistee, Mich.
" 46, D. W. FARRELL, Clayton, N. Y.
" 47, ARCHIE DE GRAW, 533 Division St., Sault Ste. Marie, Mich.
" 48, JOHN ERVING, 1510 Monroe St., Sandusky.
" 51, DONALD MCMILLAN, 105 Fourth St., Muskegon, Mich.
" 53, HARRY STONE, Marine City, Mich.
" 55, ARCHIE STALKER Electric Light & Power Plant, Cheboygan, Mich.
" 57, E. B. MEEKER, 71 Abeel St., Rondout, N. Y.
" 58, GEO. D. ANDERSON, Georgetown, S. C.
" 59, WALTER M. MILLER, 221 Saratoga St., E. Boston, Mass.
" 62, NATHAN S. LAWRENCE, 30 Connecticut Ave., New London, Conn.
" 65, WM. MCCARREL, 8 Vernon St , Charleston, S. C.
" 67, WM. S. BRADLEY, Saugatuck, Mich.
" 70, CHAS. T. SMITH, 211 Bond St., Astoria, Ore.
" 72, THOMAS NAVAGH, 40 Lake St., Oswego, N. Y.
" 73, E. B. KELLOGG, 711 W. Walnut St., Green Bay, Wis.
" 76, ORSON VANDERHOET, Grand Haven, Mich.
" 77, JOS. WEBER, 820 Buffalo St., Manitowoc, Wis.
" 78, F. A. REHDER, 29 W Superior St., Duluth, Minn.
" 80, R. P. COOK, 46 Elm St., Albany, N. Y.
" 81, JAS. L. SWEENEY, 204 E. Saragossa St., Pensacola, Fla.
" 82, FRED H. GOWELL, 4227 Middle St., Bath, Me.
" 84, N. K. LUDLOW, 15 S. Royal St., Mobile, Ala.
" 85, ARTHUR J. IRWIN, 427 Washington Ave., Alpena, Mich.
" 86, SHERMAN A. SMITH, 412 Terrace Ave., Marinette, Wis.
" 87, GEO. B. MILNE, 1003 Trumbull St., Detroit, Mich.
" 88, C. O. CHAPMAN, S. B. Canal, Sturgeon Bay, Wis.
" 89, GEO. A. TATE, 141 North Water St., Ogdensburg, N. Y.
" 91, MARTIN JOYCE, 8 Spruce St., Harbor Sta., Ashtabula, O.
" 92, JOSEPH D. BUDD, P. O. Box 50 Saginaw, E. S., Mich.
" 93, W. J. COOK, 2324 G. St., N. W., Washington, D. C.
" 94, GEO. R. JONES, Box 222, Washington, N. C.
" 101, J. C. BILLUPS, 305 Henry St., Portsmouth, Va,
" 102, CHAS. LA BOUNTY, Box 563, So. Haven, Mich.
" 103, C. H.. HALL, Box 512, New Berne, N. C.
" 104, J. H BLUMER, Moss Point, Miss.

TRADE PUBLICATIONS.

Draughtsmen will find very useful a pocket size booklet of samples of blue print papers and cloth which is ready for distribution by the Elliott Electric Blue Print Company, 723 Liberty avenue, Pittsburg, Pa. In addition to samples of paper there is much information regarding sizes, prices, quality, etc., and also regarding blue printing apparatus and other specialties.

Shipbuilders' and boiler-makers' tools, especially steam and pneumatic riveters and hammers and cranes, are the chief specialties illustrated and described in catalogue No. 27, issued by the Chambersburg Engineering Company, Chambersburg, Pa. The catalogue comprises 26 pages, and several varieties and sizes of the tools are illustrated and concisely described.

Users of search lights will find interesting a folder which is now being distributed by Thomas P. Benton & Son, La Crosse, Wis. It contains large illustrations of search lights and projectors in great variety, and much information regarding the mechanism and the construction of the lamps is given, together with names of boats upon which they are used, copies of testimonials, etc.

Wrenches and other machinists' tools, manufactured by the Billings & Spencer Company, Hartford, Conn., have a special catalogue devoted to them, copies of which can be had upon request. The catalogue comprises 92 pages and is very fully illustrated with pictures of a large line of forgings, which include in addition to wrenches of all kinds, clamps, calipers, chisels, screwdrivers, plyers, gauges, screw plates, hammers, etc.

Air compressors for use in ship yards and other engineering establishments where pneumatic tools are used have a very handsome catalogue devoted to them, just issued by the Rand Drill Co., 100 Broadway, New York. The catalogue is a very handsome specimen of typographic work and is very fully illustrated with a large number of compressors of different types and sizes and contains much valuable information on the subject of the use of compressed air.

Shaw's compound propeller pump is one of the recent specialties being put on the market by the Quinby Engineering Company, 915 Ridge avenue, Philadelphia, Pa., and which is described and fully illustrated in a large, 4-page folder which is now ready for distribution. The designing of the pump is fully illustrated and its application is well explained. The descriptive matter is very complete, stating that the pump is especially suitable for use in dry docks, tank steamers, etc.

Sheets and pillow-cases for yachts, steamships and other vessels are the specialties manufactured by the Defender Mfg. Co., which are told about in considerable detail in two booklets ready for distribution. One booklet describes the factory and the different styles of finish of goods. The other is devoted almost exclusively to illustrations of the drawn work and other forms of finishing. Copies of these booklets, with full information regarding the different sizes, qualities, etc., can be had from the Defender Mfg. Co., New York.

Electric steering gear, manufactured by the Electro-Dynamic Company, 224 Ionic street, Philadelphia, Pa., has a special catalogue devoted to it, which is now ready for distribution. The frontispiece is a fine picture of the Russian cruiser, *Variag*, which is equipped with this steering gear, and which shows the vessel at high speed when on her trial trip. The text of the catalogue is very complete and many illustrations are given of the motors, generating sets and of the gear itself as it is installed in the ship. It is a catalogue of unusual qualities, as far as appearance goes.

Users of springs will find a very complete catalogue in the one which has just been issued by the American Steel and Wire Company, Worcester, Mass. The subject is fully covered, including springs and coils of every style, size and shape and for all uses.

The Sprague Electric Company, 527 West Thirty-fourth street, New York, describes, in its latest bulletin, No. 204, the application of Lundell motors to electric vehicles. There is considerable information regarding the motors and several illustrations are given showing the manner in which the motors are applied to vehicles of different types.

Yachtsmen and other users of small boats will find most useful and instructive a catalogue which has just been issued by the Marine Engine & Machine Company, Harrison, N. J. Two fine launches are illustrated, one a 36 footer, with a draft of only 13 in. and equipped with an alcho vapor motor. Another picture is of a 35 footer drawing 30 in. of water. Quite a little attention is also given to yacht tenders equipped with alcho-vapor motors.

"Something About Coverings" is the title to a pocket size booklet on the subject of asbestos covering which has just been issued by the H. W. Johns Mfg. Co., 100 William street, New York. The descriptive matter is very complete and a large number of illustrations are given, showing the manner in which asbestos covering is applied to numerous uses. What adds much to the interest of the booklet is the series of pictures, two of which are of the tanks in the Standard Oil plant which were destroyed by fire in New York Harbor last summer. These pictures are exceptionally fine.

Users of electric specialties and lamps will find valuable a series of bulletins issued by the General Incandescent Arc Light Company, 572 First avenue, New York. The bulletins show a great variety of incandescent arc lamps. The mechanisms by which the lamps are operated are fully illustrated and described, and many types of lamps, some of which are exceedingly decorative and effective, are shown. Other bulletins include specialties that go with electric work, such as push buttons, switches, circuit breakers in large variety, junction boxes, ventilating fans in great variety and incandescent bulbs.

Pumping machinery manufactured by the Epping-Compenter Company, Pittsburg, Pa., is most completely and thoroughly illustrated and described in a fine catalogue comprising 60 pages, which is now ready for distribution. The printing is on heavy coated paper, in red and black. The illustrations are large and of excellent quality, and altogether the catalogue is a most business like one and excellent from a mechanical point of view. An index adds much to its completeness, showing the great variety of pumps manufactured by this company. They include bilge pumps, boiler feed pumps, air pumps, circulating pumps, fire pumps, etc. There is also considerable useful information on the subject of pumps and hydraulics.

Death of Mr. J. B. Gray.—Mr. Jerome Bethel Gray, whose death occurred on October 19, at his home in West Chester, Pa., filled the measure of a man and a gentleman, and those who knew him best will feel his loss most. He combined to a remarkable degree social graces, kindness of heart and the acumen which secures success in business. Those who were fortunate enough to have been associated with him will realize that death deprived them of one whose life made living easier for others, his readiness to do a friendly turn and his willingness to smooth out the pathway for others if he could was always in evidence. To have lived fifty-two years and to have filled a position in the world with honor and credit, and to have departed this life with the universal respect and sorrow of his acquaintances and friends, is an eloquent tribute which he earned. During Mr. Gray's business career he was connected with the firm of Hoopes Bros. & Darlington, of West Chester, and for the last two years with the Wm. S. Haines Co., of Philadelphia.

"Westinghouse Railway Motors" is the subject of an excellent and well edited catalogue just issued by the Publishing Department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. The right hand pages are very generally devoted to illustrations of motors, large electric plants, etc., and the type matter is on the left hand pages.

The New York Blower Co., Bucyrus, O., has just issued and now has ready for distribution an exceptionally well printed and complete catalogue devoted to its many specialties. The catalogue is inclosed in a handsomely embossed cover in three colors and the text is printed on a fine quality of coated paper in two colors. Among the specialties described and illustrated are blowers, exhausters, engines, mechanical draught outfits, etc. The illustrations are numerous and add very much to the value of the catalogue. There are important tables of speed, together with much other valuable information of use to any engineer having to do with heating and ventilating. It is an exceptionally handsome catalogue.

As thermometers are coming to be very generally used on larger steam vessels, especially in the stacks, also on feed and steam pipes, feed tanks, hot water wells, etc., the catalogue on high grade thermometers and gauges manufactured by the Hohmann & Maurer Mfg. Co., Rochester, N. Y., will be of interest to many of our readers.

Eberhard Faber, 545 Pearl street, New York, issues a very complete catalogue, which will be found valuable for purposes of reference in draughting rooms and business offices, as it is devoted to the full line of lead pencils, penholders, erasers and other specialties of this firm. The catalogue is very handsomely printed with an index to the 100 pages.

The Chicago Pneumatic Tool Co., Monadnock Block, Chicago, is now distributing in this country the Exposition edition of its catalogue. It is a book of nearly 100 pages, 6 by 9 in. in size, and contains almost exclusively of full page pictures showing pneumatic tools of all kinds in actual operation in ship yards, on board ship and in engineering establishments. The text consists of a few words serving as titles to the pictures, being printed in English, French and German. The catalogue is an especially fine specimen of typographical work.

The Vezin high speed engine is illustrated and described in a compact catalogue just issued by the Vezin Machine Co., 97 Liberty street, New York. As stated in the introduction, this engine is designed especially for high speed work, varying from 1,500 revolutions down. An engine of over 5 H. P. is illustrated and described. It weighs 150 lbs., has a speed of 1,500 revolutions, is 23 in. high, occupies a space of 11 by 15 in. and a bedplate of 5 by 9 in. The construction of the engine is described and much useful information is given.

Induced draught is very thoroughly and exhaustively discussed from a commercial point of view in a handsome and complete catalogue, comprising 60 pages or more, with many folded insertions, issued by John Brown & Co., Ltd., Sheffield, England. The first part of the book is devoted to a discussion and consideration of the subject of mechanical draught. The latter part of the book is given up to engravings and plans of fans and engines and other apparatus as applied by this company. We suppose that duplicate copies of the book can be had upon application by referring to MARINE ENGINEERING.

Electric heaters have become so extensively used in steam yachts and passenger vessels that they have now become quite a necessity. These heaters are manufactured in large variety and suited to all peculiar conditions by the Gold Car Heating Co., Frankfort and Cliff streets, New York. This company is now distributing a catalogue which goes very thoroughly into the subject of electric heating and which contains many illustrations of heaters of different kinds, altogether making it a book of much merit and value to those who have to do with the heating of vessels of any kind where electric power is available.

A most complete line of electric light and power specialties and signalling devices is shown in a catalogue issued by Zindars & Hunt, 52 Grove street, New York. This comprises switches of every description and suited to currents of various kinds, connecting lugs, switch board connections and instruments, complete switch boards and all of the attachments that go with them and other electric specialties.

Users of small air pumps and receivers for any purpose will be surprised at the great variety of applications shown in a catalogue issued by the Gleason-Peters Air Pump Company, Houston and Mercer streets, New York. The Power receivers are extensively used on board vessels for operating fog signals, whistles, etc., and smaller ones are shown in which fog signals are operated by hand and foot power. These are only a few of the numerous applications.

Users of paint will be interested to send for a booklet issued by the Theodore Saunders Company, 150 Nassau street, New York, descriptive of the different lines of paint manufactured by this company. Considerable space is devoted to describing Diamond Liquid Iron paint, Invincible paint for stacks, boiler fronts and for all parts of steamships. This paint is made in several colors. Other specialties referred to are boiler and tank paint, etc. Copies of the booklet can be had by mentioning MARINE ENGINEERING.

Pneumatic tools, hammers, riveters and drills, manufactured by the Cleveland Pneumatic Tool Company, Cleveland, O., are fully described and thoroughly illustrated in a catalogue just issued. It is printed on heavy coated paper and the illustrations are strong and very effective. As the illustrations are all of them of large size and show the tools in actual operation, the catalogue is made so much more valuable. Several pages are devoted to text, describing not only special tools, but the general use of pneumatic appliances.

Two catalogues have just come to hand from the B. S. Sturtevant Company, Jamaica Plain, Mass. One is the third edition of a catalogue devoted to steel plate fans. It is a large and very complete book containing valuable matter. The other is devoted to the Sturtevant system of heating, ventilating and moistening.

A 4-page folder is issued by the Naval Electric Company, 95 Liberty street, New York, describing the "Yale" lamp, a recent invention by which electricity can be utilized under water. Brief mention is also given of the other "Naval" specialties of this company, including generating sets, search lights, bunker lamps, electric winches, etc.

Hack saws and frames in considerable variety, which are manufactured by the L. S. Starritt Company, Athol, Mass., are illustrated and described in an 8-page folder. This company also issues other little folders, one devoted to nail sets and center punchers; another to fine tools for mechanics, and the third to speed indicators.

"About Yachts and the Best Machinery to Run Them" is the title of a catalogue just issued by John E. Thropp & Sons Company, Trenton, N. J. Pictures are given of different types of engines which this company manufactures, simple, compound and triple expansions, of high speed yachts, surface condensers, propellers, Boyer water tube boilers and other types.

Many marine specialties of much importance are manufactured by the Fuller Company, Detroit, Mich., and shown in a catalogue which is now ready for distribution. These include an automatic engine generator, the engine being of the Fuller pattern, which has only recently been put upon the market, air propellers, small yacht lighting sets, ventilating fans and blowers in considerable variety, switch boards and appliances, yacht engines and other specialties. The catalogue is one that should be in the hands of every man having to do with marine work.

BUSINESS NOTES.

Mexican Government Work.—The Johnson Iron Works, Ltd., New Orleans, La., have been building for the Mexican Government a 60-ft. tug. The tug has a wooden hull, a water tube boiler, a Wheeler condensing equipment and a 3-cylinder triple expansion engine of the Company's own design and manufacture. The tug was launched early in November. According to a press dispatch, she was designed by Mr. Warren Johnson and is to make a speed of 12 knots.

New Lunkenheimer Shop.—The new machine shop building which The Lunkenheimer Company has just completed is situated on the block bounded by Tremont, Waverly and Lawnway streets, Fairmount, Cincinnati. This building is 90 ft. wide by 170 ft. long, two stories and basement, and is built on the usual machine shop gallery style of construction. There is a traveling crane 30 ft. wide which runs the full length of the building, leaving galleries on the second floor, on both sides, 30 ft. wide. The construction is steel throughout and designed to safely carry a load of 300 lbs. per sq. ft. This building was erected for the purpose of taking care of three important departments of the company, viz: Iron valve, injector and safety valve. It is a model machine shop and is equipped throughout with the very latest tools and appliances. The steam plant consists of a 125-H. P. water tube boiler built for a safe working pressure of 400 lbs. per sq. in. In connection with this boiler there are a number of appliances for testing all goods under steam, air and hydraulic pressure. The building is lighted by electricity and the power is furnished by a 100-H. P. engine. The exterior of the building presents a very handsome appearance, being pressed brick throughout. The location is an excellent one for manufacturing, railroad facilities are ample and a track spur from the C. H. & D. railroad leads to one side of the building. The erection of this building will not in any way reduce the building now occupied by the Company on East Eighth street, Cincinnati, which will hereafter be entirely devoted to brass work. The Company contemplates the erection of a large building on some other property which it owns, which is adjacent to the new building, but it is not likely that this will be carried out for another year. By the erection of this new building the manufacturing facilities have been increased about 25 per cent, and employment is given to one hundred men in addition to the force already operated, bringing the total force up to five hundred hands.

Kingsford Marine Apparatus.—The Kingsford Foundry and Machine Works, Oswego, N. Y., have entirely rebuilt their plant since the recent fire and added much new machinery and otherwise increased their facilities. This Company is now offering a line of marine engines up to and including 15 and 30 by 28 in. The Company builds a very complete line of side suction pumps and three types of double suction pumps in all sizes. These pumps have been designed for low, medium and high lifts and can be driven by belts, direct connected engines or motors. In marine boilers the Company is doing a very large business in internally fired boilers of the Scotch, leg and patent "Eclipse" type.

VENTILATION.—The contract for ventilating the remodelled Grand Central Station, in New York, was awarded to the Sprague Electric Company, 527 West Thirty-fourth street, New York. The order called for a large number of fans, ranging in size from 18 to 60 in., all of them operated by Lundell motors.

THE PARAGON BOILER.—Captain M. De Puy, 19 South street, New York, inventor and manufacturer of the Paragon boiler, informs us that he is now building two 150-H. P. boilers for marine service, each to carry a pressure of 150 lbs. He also has several other orders, one for four 250-H. P. boilers, another order for two 250-H. P. boilers. A recent improvement in this boiler consists in running the water space in the centre legs up through the combustion chamber. This adds 14 sq. ft. of heating surface. This improvement also simplifies the construction of the boiler. Another change in the boiler is the use of the water bridge in both furnaces, thereby increasing the effective heating surface.

CORRESPONDENCE INSTRUCTION.—Ambitious mechanics who desire to obtain better positions and higher wages should investigate the Free Scholarship offer made in another column by the American School of Correspondence, Boston, Mass. Situated in a large city which is a recognized educational and industrial center, this well-known correspondence school has many natural advantages in teaching the theory of the trades and engineering professions. Without leaving home or losing time from work, the student pursues a thorough course of study under the direction of able instructors, who are always ready and willing to assist him. Instruction papers, prepared especially for teaching by mail, are furnished free. These papers, written in clear and concise language, are as free as possible from technicalities. In addition, special information regarding any difficulties in their studies is furnished students without extra charge.

BENT GROOVING CHISEL.—We are informed by the Mound Tool & Scraper Company, 710 Howard street, St. Louis, Mo., that it is sending free with every order of goods, of whatever size, from the readers of MARINE ENGINEERING, a Bent grooving chisel for cutting oil ways in engine brasses and bearings.

NEW YORK BLOWER COMPANY.—Owing to the great increase in its business, the New York Blower Company, whose head office and factories are at Bucyrus, O., has found it necessary to open a branch office in Chicago, in the Merchants' Loan and Trust Building. The Company now has offices in New York, Boston and Chicago.

LINE CARRYING GUNS.—Wm. Read & Sons, 107 Washington street, Boston, Mass., are offering the Lyle line carrying gun, which is made in accordance with government regulations and which is already used very extensively on seagoing vessels of all sizes. Circulars and other information regarding the guns can be had upon application.

PEERLESS RUBBER GOODS.—The Peerless Rubber Manufacturing Company, 16 Warren street, New York, has made Mr. Leonard J. Lomasney its general sales agent. This is a promotion and a compliment to Mr. Lomasney, as he has been connected with the company for several years in the sales department. The recent increase in trade has made it necessary to extend the scope of this department.

TEA AND COFFEE URNS.—Nearly every vessel of any size has on board tea or coffee urns of greater or less capacity. The demand for these specialties has been such that A. G. Miller, 106 Centre street, New York, is putting on the market a line of improved urns designed especially for ship uses. These have already been introduced on transatlantic and coastwise vessels. A very complete catalogue, illustrating the various sizes and types of urns, together with other specialties, is sent upon application.

SEMI-BRONZE METALLIC PACKING.—The Charleston Metallic Packing Company, Charleston, S. C., reports a steady increase in the sale of its semi-bronze packing. A large order has just been delivered to the U. S. Government for the Brooklyn Navy Yard. The Company has found it necessary to increase its plant and is now offering, in addition to the bronze packing, a line of flax and plumbago packings. Arrangements have been made to have the packings handled in foreign countries, even in Russia, Siberia and Bulgaria.

A MAIDEN TRIP.—The small steamer *Lady Jane* has just been delivered by the Marine Iron Works, Chicago, Ill., under her own steam to the Hand Lumber Co., Mobile Bay, Ala. She made the 2,000-mile trip from Chicago in a manner that was very pleasing to all concerned, both from an enjoyable as well as economical and practical standpoint, the route being via Chicago River and canal to the Illinois River, thence via the Mississippi. Any who may contemplate making that very interesting trip, either all or part way, can secure information regarding it by addressing Marine Iron Works, Station A. Chicago, Ill.

BETHLEHEM STEEL COMPANY.—The Bethlehem Steel Company, 100 Broadway, New York, has appointed the Abner-Doble Company, Fremont and Howard streets, San Francisco, Cal., agents on the Pacific coast for Bethlehem forgings and other specialties.

BABBITT METAL.—The Columbia Smelting and Refining Works, 307 Water street, New York, make a specialty of Babbitt and other metals for bearings. The company has a large establishment devoted exclusively to this business, and information regarding the different grades of metal will be furnished upon application.

BALL BEARING JACKS.—There is a steadily increasing demand in marine work for jacks, and in order to fully satisfy the demand A. O. Norton, 167 Oliver street, Boston, Mass., is making, especially for marine work, a line of ball bearing ratchet screw jacks. These jacks are designed to be as safe, as light in weight and as durable and as low in price as possible. For their size they have great capacity.

FOUR THROW ENGINE CRANKS.—The William S. Sizer Steam Forge Co., Buffalo, N. Y., has recently received and filled an order from the Holland Torpedo Boat Co. for the seven four throw crank shafts which are to be used in the submarine torpedo boats lately contracted for by the Government. These cranks are made of open hearth steel specially rolled for the purpose and are finished complete. Each shaft in its finished condition weighs 1,460 lbs.

A NEW REPAIR PLANT.—Mr. C. C. Hanley, who has for some time been in the yacht building business at Quincy Point, Mass., has combined his plant with the docking and repair works of L. D. Baker. The new company will be known as the Hanley Construction Co. and the capitalization is $250,000. It is understood that the company will build dry docks and be prepared to do extensive repairing on steam vessels as well as the building and repairing of yachts.

STURTEVANT APPARATUS.—"2500 Witnesses" is the suggestive title of a 58 page production of the advertising department of the B. F. Sturtevant Co., Jamaica Plains, Mass. As announced in the subtitle, it is "A List of Buildings and Sundry Steamships Wherein the Sturtevant System or Apparatus Has Been Installed for the Purposes of Ventilation and Heating." The introduction contains this statement: "Some evidence is usually demanded by the prospective purchaser as to the extent and success of the application of the article or system under consideration. Printed testimonials, no matter what their tenor, are always more or less questionable as to their character. But a comprehensive list of purchasers and users, to each and every one of whom the inquirer is at perfect liberty to apply for information, forcibly presents, by its very numbers, the most indisputable evidence of widespread adoption and provides the best possible opportunity for searching inquiry as to success. Such is the list which follows. These names are the most emphatic witnesses that this Company desires to present as evidence of the successful operation of the Sturtevant system and apparatus.

A SATISFACTORY LAUNCH.—In writing recently to the Marine Engine and Machine Co., Harrison, N. J., regarding a launch which he recently purchased from this company, Mr. Lawrence Jones, of Louisville, Ky., stated: "I have used four different types of launches, or rather engines, hot tube, electric spark, the regular naphtha and the alcho-vapor. There is no possible comparison. The alcho-vapor is infinitely superior to anything I have ever tried; in fact, in my judgment, it is the only power for a small boat. My launch last year ran over 7,000 miles without a skip of any kind. She never stopped once on account of the engine. It is positively a pleasure to endorse your engine."

INCREASED FACILITIES.—The Voorhees Rubber Mfg. Co., Jersey City, N. J., has constructed a large addition to its works, which will give a much greater manufacturing capacity and enable it to turn out orders promptly. The new building is 50 by 150 ft., constructed of brick, four stories in height, and has all the improved modern mill construction. The building is equipped with the latest improved machinery, including new engines, hydraulic presses, etc. With this addition to its facilities the company will have double its former capacity. The company will now be prepared to fill promptly orders of any size for Nubian Packing, together with its other specialties, such as hose, valves and other rubber goods.

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